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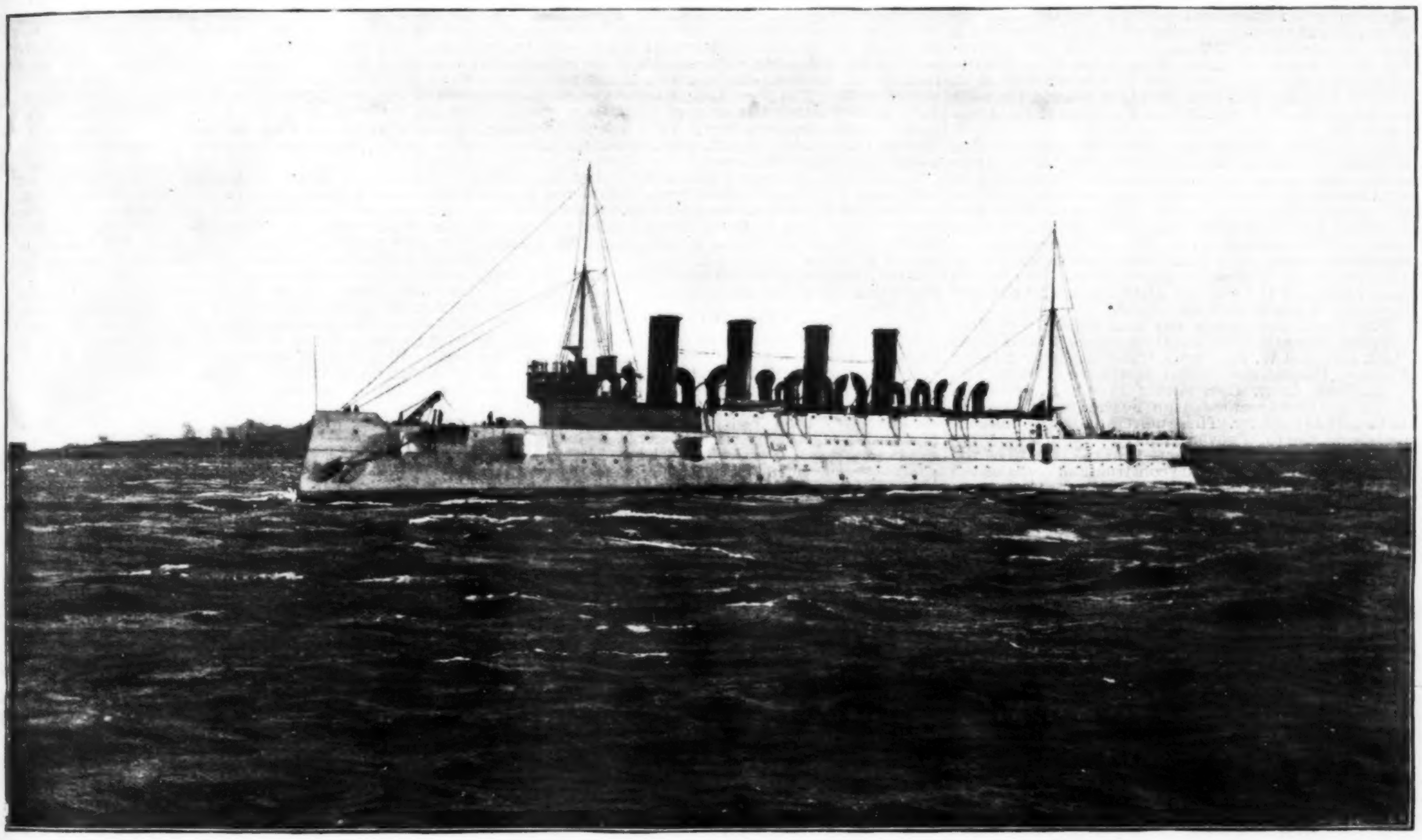
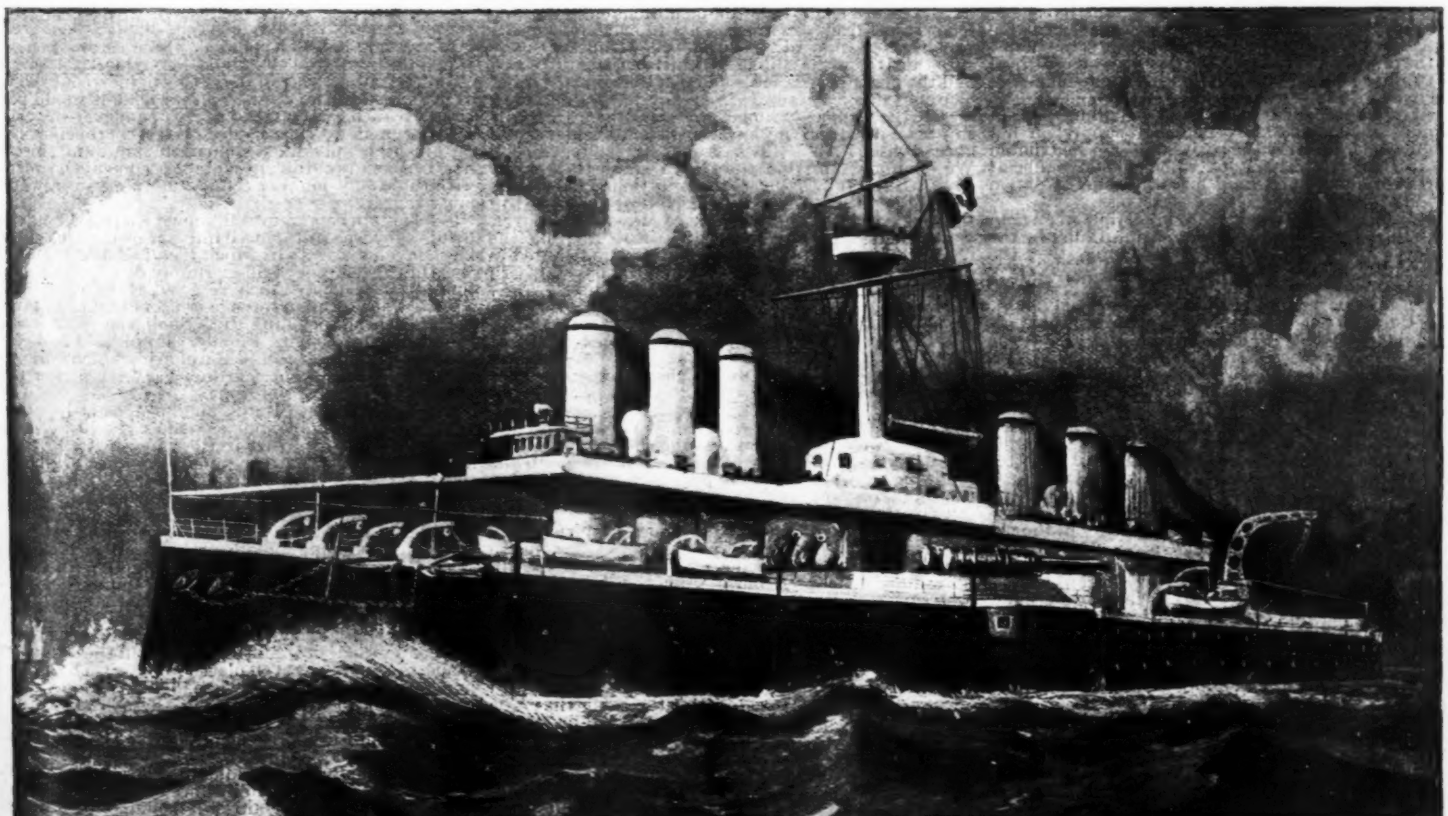


THE NEW AMERICAN WAR SHIP COLUMBIA.



THE ITALIA (OF THE ITALIAN NAVY), THE LARGEST WAR SHIP IN THE WORLD.

15,900 tons displacement, 400 ft. length, 74 ft. beam, 18,000 horse power, carrying four 100-ton guns and twenty-four smaller guns, etc.

THE TRIPLE-SCREW WAR SHIP COLUMBIA.

THE official speed trial of this our most recently built war vessel took place November 18, a previously attempted trial on November 16 having been given up on account of bad weather, although the engines were said to have worked smoothly, developing more than the power called for by the contract. The course was almost directly north from a point off Cape Ann, Mass., a distance of 43·96 nautical miles, the vessel crossing the line at full speed, making a long turn, and taking another run over the course in the opposite direction. According to the arrangements made, the times of passage over the course alone were to be taken, the time of turning being eliminated, but during the turn no change in engines or boilers was to be permitted, and not a valve or link was to be touched.

The starting line was crossed at 9:54:40, and at 11:49:48 the ship dashed across the finish line, completing the first half of the trial, the average speed having been 22·92 knots. During this run the steam pressure had risen to 158 pounds, and revolutions 136 each on the twin screws and 131 on the midship screw, and the last seven miles was said to have been made at the rate of 25·3 knots an hour. After turning in a circle of about four miles diameter, the run back was commenced, the line being crossed at 12:14:58, with a steam pressure of 160 pounds, the twin screws making 136 revolutions each and the midship screw 130.

During the backward run there was some priming of the boilers at one time, and the speed between two of the stations on the course dropped to the rate of 21·11 knots, but the total backward run was made at the average rate of 22·71 knots. The mean of the two runs was, therefore, figured as 22·81, and the builders have earned a premium of $350,000 for attaining a speed of seven quarter knots over that called for by their contract. The naval officers aboard are said to have expressed the highest satisfaction with the performance of the vessel throughout.

The board conducting the trial consisted of Rear Admiral George E. Belknap, Commodore J. G. Walker, Capt. Edmund W. Matthews, Chief Engineer Edward Farmer, Commodore Philip H. Cooper, Commander F. A. Cook, Lieut. Commander Joseph N. Hemphill and Naval Constructor Joseph Feaster, with Lieut. L. L. Reamy as recorder. These officers had also numerous assistants, the total government inspection force numbering no less than 36 officers—13 of the line, 20 of the engineer corps, and 3 of the construction corps of the navy. While the determination of the speed alone required nothing save the accurate marking of time at the passage of certain ranges, and the careful computation and correction of the resulting speed, there were yet a host of subjects concerning which the government officers were deputed to gather numerous and thorough data. Indicator diagrams were taken at close intervals from every engine on board, and from these will be determined pressures, horse power, and other information of great value to the navy department, not only for use in relation to the Columbia herself, but as a guide and assistance in future engine designing. Temperatures of fire rooms, fuel, water, etc., were also carefully noted.

The Columbia is 412 feet long on the load water line, 58 feet extreme beam, 22 feet 6½ inches normal draught, and displaces 7,350 tons. Her power consists of three three-cylinder vertical inverted triple expansion engines, having about 22,000 collective indicated horse power and driving three screws, one on the middle line, as in single screw ships, and the other two under the counters, as in twin screw vessels. This power is calculated to produce a speed of 21 knots an hour, which the contract for the vessel calls for, but the builders will receive a bonus of $50,000 for every quarter knot the vessel makes over the required twenty-one knots. Our engraving is from *Once a Week*.

The engines are in three separate water-tight compartments, the two driving the counter screws being placed abreast the same as in twin screw ships, and the one driving the center shaft just abaft them and lapping each for one-half its width. Steam is supplied by eight four-furnace double-ended boilers. The weight of all propelling machinery, including water in the boilers, is 1,950 tons. The coal supply on her normal displacement is 1,200 tons, but her maximum bunker capacity is 2,200 tons, which will give her at the most economical cruising speed a radius of action of about 16,000 knots.

The application of power through triple screws in large ships is an innovation, and its results in the Columbia are watched with intense interest by the entire civilized world. Essentially and avowedly a commerce destroyer, and not a fighting ship, the armament of the Columbia will be comparatively light.

The Columbia has been in a special degree the work of Engineer-in-Chief G. W. Melville, U.S.N., of the Bureau of Steam Engineering, under whose direction the designing of her machinery was done. When the estimates were made for this ship, the speed fixed was twenty knots, but after the naval appropriation bill was passed, it was found that in conference the speed had been raised to twenty-one knots, and Mr. Melville decided that the ship should have from 20,000 to 21,000 horse power, and at once began to lay out the engines and boilers. It soon became apparent that twin screw engines would not do, because of their size and the fact that they would be very extravagant in the use of steam at the ordinary cruising speed. Besides this, the space that could be given up to machinery was restricted, and would not be satisfactory for twin screw engines. Mr. Melville then decided that triple screw engines were the only ones that would do, and at once set about the preliminary design. Through the course of her construction he has watched the machinery carefully, and the success which she has achieved marks a new era in marine propulsion.

Having thus presented what might be termed the official side of the recent trial, and given the highest figures which the contractors were able to squeeze out of the ship, let us consider how her performances compare with some other existing vessels, and whether the Columbia is, after all, the fastest vessel afloat, as claimed, whether she is truly a "commerce destroyer" and able to, as asserted, overtake any other cruiser.

The Columbia's displacement is 7,350 tons, her collective engine force 22,000 horse power, average speed 22·81 knots on a short trial trip, strained and driven to the utmost with the hottest fires possible, burning picked coal in quantities greatly in excess of any other ship, every bearing flooded with oil. Even under these conditions her rate fell at times to 21·11, and the indications are that it was impossible for the Columbia to have made 25·3 knots as stated, and that she could not maintain even the speed of 21·11 knots on a voyage of any considerable length, say from New York to Southampton. It is doubtful if on such a voyage she could maintain an average of 19 knots. The two new Cunard ships Campania and Lucania, built to serve as cruisers, whenever required, each have a displacement of 12,500 tons, 620 feet length, 65 feet beam, 15,000 horse power twin screws. The power of the Columbia is far greater than these ships and her displacement far less. And yet these ships have maintained an average speed on runs of about 3,000 miles of 21·3 knots, and on some entire days 22·3 knots. This is on regular commercial employment. There is little question that if strained for a spurt as was the Columbia, they would beat her; and it is absurd to expect the Columbia could overtake either of them on a lengthened voyage. The steamers Paris and New York are both built to serve as cruisers when required. The speed of the Paris on her trial trip was 21·8 knots, same as the Columbia. The length of the Paris is 560 feet, beam 63 feet, displacement 13,000 tons, horse power 20,605. The New York same dimensions. The Teutonic is another fast ship of 12,000 tons displacement, 18,000 horse power. Trial speed 21 knots. Several other boats, built to serve as cruisers, of about equal speed could be named.

The Japanese cruiser Yoshino is 350 feet long, 46½ feet beam, 4,000 tons displacement, 15,000 horse power, and on July 11, 1893, on her trial trip, attained as the mean of four runs on the measured mile a speed of 23·031 knots, of which the fastest run with the tide was 23·76 knots.

The Columbia, although greatly superior in power, ranks below the Yoshino in speed.

SPEED TRIALS IN THE NAVY.

"The result of the official trial of the Columbia is highly satisfactory. While the precise speed of the vessel cannot be determined until the experts have leisure for revising their calculations, there is *prima-facie* evidence for justifying the conclusion that all records have been broken. The Columbia is the fastest ship afloat either in the naval or in the merchant service. Her performance is unparalleled. The contract requirements have been exceeded so largely that the builders will be entitled to very heavy premiums.

"Criticism upon the methods employed in the navy may seem untimely and ungracious when the triumphs of American designers and shipbuilders are made a matter of record; but it may serve a useful purpose. The fact cannot be too strongly emphasized that the present system of premiums is costly, unnecessary, and promotes dangerous tendencies. It is expensive, because it largely increases the cost of nearly every vessel added to the navy. It is unnecessary, because the arts of modern naval construction have been mastered by shipbuilders, and lavish rewards for the development of speed are no longer needed in order to obtain the best results. The English designers of the Campania and the Lucania were required to produce ships of great tonnage capable of crossing the Atlantic in five and a half days. They succeeded without premiums, because they understood their business and knew how to calculate on the basis of weight and horse power. The designers and builders of naval vessels can do their work with equal precision. Premiums ought not to be required as an incentive for exceeding contract requirements. They are not only unnecessary, but they involve the sacrifice of all other elements to speed; and that cannot be done without risk of impairing the general efficiency of a ship.

"The record made under the conditions of yesterday's trial is artificial. It represents a maximum speed which will never again be developed. In order to secure this record the ship is racked from stem to stern and the machinery is subjected to a tremendous strain. The contractors obtain their premiums, the designers receive the commendation of the department and the ship is credited on the naval registers at home and abroad with a speed which is nominal and artificial. We do not think that the record is worth what it costs. Entirely apart from the premiums paid to the contractors, the strain of an official trial conducted in their interest is injurious to the vessel. Moreover, when the builders have everything to gain from the development of exceptional speed they are tempted to overlook all other requirements, and thereby to sacrifice highly important qualities of the ship."—*N. Y. Tribune.*

THE COLUMBIA'S PERFORMANCE.

ALTHOUGH the trial board which participated in the remarkable trip of the cruiser Columbia off the New England coast has not yet made their official report, it is known that they are extremely pleased with the results. Mr. Edwin S. Cramp, who had charge of the vessel, representing the contractors, has drawn up the following report of the Columbia's performance during the actual test and on the run home:

"The steaming capacity of the boilers is ample for any demands that will ever be made on them, and a high rate of speed can always be reached and maintained with ease and safety. The department will never have to fear any harm from the severest tests they can ever be subjected to. This fact was so apparent to all that engineers and officers aboard have declared that Chief Engineer Andrade will be able, as soon as his crew is thoroughly drilled, to surpass the record achieved on the trial, as he did in the case of the Yorktown. He made half a knot better speed with that vessel than was recorded on the trial trip. The indicated horse power of the Columbia will be largely in excess of the estimate, and will reach 22,000. It is a matter of sincere gratification that, with all the machinery aboard, in as severe a test as any man-of-war was ever subjected to, nothing went wrong. The adjustments were perfect, and we are in condition to go on a trip around the world just as soon as the bunkers are filled with coal.

"The most noticeable feature of the trial of the ship itself was the remarkable absence of all wave. The triangular foaming cataract at the stern formed with its apex about ten feet from the ship, and then subsided in height as it spread in width until it disappeared fifty feet further aft into a series of gentle waves similar to those seen in the wake of a stern-wheeled steamboat. The bow wave is light and mostly spray, which, being caught by the hawse pipes, is broken into showers and blown over the decks in sheets. When at maximum speed there was little or no vibration of hull except when passing over the shoal places, when the engines would slow down, and a panting, leaping motion would become apparent, as if the ship was being held back and was striving to break its bonds.

"Too much praise cannot be given to the engineer crew, from the chiefs to the firemen and coal passers. All did their duty with vim, and each man had a personal, living interest in the success of the ship. In a trial like this, the negligence or ignorance of one man might nullify the endeavors of all the rest.

"The engineer corps of the navy conducted an extensive trial on the way back from Boston, of eight hours' duration, to test the efficiency of the twin screws with the center screw disconnected. At the same time the consumption of coal was carefully weighed in the fire rooms, and four boilers only were used, with the same air pressure as was used on the official trial the day before. The object of this was to obtain definite data as to the consumption with forced draught, so that the radius of action of the ship at the maximum speed can be accurately determined.

"To make it clear, I will state in figures that for eight hours, with nine-tenths of an inch air pressure in fire rooms, with steam on only four boilers, with the side screws working and the center screw disconnected, the ship made 18·87 knots per hour, 140 pounds of steam being recorded in engine room, the port engine making 116 revolutions and the starboard engine 113 revolutions per minute. From 6:30 P. M. on Sunday to 8 A. M. on Monday we ran with natural draught and steam on six boilers only, and averaged 18 knots with the same screws as with the above forced draught trial. We averaged 140 pounds of steam, 115 revolutions per minute of port engine and 110 revolutions per minute of starboard engine. From midnight until daybreak we were in heavy northwest gales, the ship was drenched with water, and the side screws raced considerably.

"The data collected by the engineers, under direction of Chief Engineer Edward Farmer, is very complete, owing to the interest that every member of the supplementary board took in the matter. Not the slightest hitch occurred, and the skill that the members of the trial board showed in their different stations amply justified the appointment of a permanent board for conducting the trials.

"The engineer officers of the board, with less congenial duties than their fellow members, clad in greasy and grimy overalls, did their duties earnestly down in the engine and fire rooms, where oil rained, hot air rushed, and cinders and ashes flew. Engineer-in-Chief Melville should be doubly gratified at the results obtained, as they prove that his courage and foresight in the advocacy of the triple-screw principle to the fast cruisers has been an evidence of rare judgment. Speaking for the builders, I can say that we are as proud of the Columbia as it is possible to be of the fastest cruiser that ever braved an ocean wave. We are proud of her as an American vessel and proud of her because she comes from Philadelphia."

San Francisco, Nov. 22.—The cruiser Olympia, which recently returned from her contractor's trial trip at sea, in which she made over twenty-one knots an hour, sailed this morning for Santa Barbara Channel, where her official trial trip will take place, probably on Friday morning.

TRIPLE-SCREW PROPULSION.

IT was not, indeed, the use of three screws instead of two that gave the Columbia her remarkable speed record. If the power of her big engines could have been applied to two screws on that trial, it would perhaps have achieved a speed as great, and possibly even a little greater. But the use of three propellers has certain other advantages of much value, and since it has been shown that splendid speed may be made with three, any doubt as to their usefulness as a whole must vanish.

Triple propellers were well known in foreign navies before they were introduced into our own. One of the most famous vessels to which they had been applied was the great French cruiser Dupuy de Lome, of 6,297 tons displacement, which received them years ago. Again various Italian torpedo cruisers had been fitted out with them, including the Tripoli, the Montebello, and the Monzambano. Finally, the splendid and very fast German cruiser Kaiserin Augusta, which was present in New York at the international review last spring, had them at that time.

Thus it is not at all an experiment that has been tried on the Columbia, but a well-established system of propulsion. A further justification of its adoption here was the fact that the proper manner of placing the screws had been fully determined by European practice. The French made all the necessary experiments with their steam launch Carpe, and they ascertained that if all three propellers were placed abreast, the center one would not do so much work as it should, since the water flowing to it was interfered with by the two side drums. Hence in the Dupuy de Lome the center propeller was placed aft of the other two, and the same arrangement was followed in the Columbia, where it is 15 ft. aft. Again, further to secure the greatest efficiency for all three screws in the Dupuy de Lome, they were not even placed in the same horizontal line, but the two side ones were higher, with a view to prevent their race from injuring the efficiency of the central propeller. This arrangement was also adopted in the Columbia, improvements, of course, being made upon it as far as possible.

In the Columbia the middle propeller is about 4¼ ft. below the two others, and inclines slightly downward, while they, on the contrary, incline outward and slightly upward. This makes it still freer from being affected by their motion. As it is 1¾ ft. smaller in diameter, it has four blades, while they have only three each. Again, as it works partly in water thrown aft

by the starboard and port screws, it has rather a coarser pitch, amounting, it is said, to about one-tenth.

The machinery of the Columbia was designed by Chief Engineer Melville, and any improvements over triple screws as used elsewhere should be passed to the credit of our engineering authorities. It is believed also that the fine shape of the Columbia's hull assists the free run of the water along to the screws. The middle propeller is placed in the midship line, close down to the keel and just forward of the rudder, while the others are located above, one under each counter, and, as has already been indicated, forward of the stern post. The Messrs. Cramp built the engines of the Columbia strictly on the designs of Chief Engineer Melville.

The introduction of the triple propulsion system in Europe had come at a peculiarly fortunate time for our purpose. It was desired to give the Columbia an engine power unprecedented in our navy. An aggregate of at least 21,000 indicated horse power was fixed upon, or more than double that of any vessel then in commission. But an obstacle presented itself in the fact that it was very doubtful whether shafting heavy enough could be procured here for the purpose, and the law requires the machinery to be of American manufacture. With twin screws, each shaft would have to be heavy enough to carry 10,500 horse power, and it was thought that at least great delay would result in procuring such shafting, besides the attendant risk. In England it could have been got, but that was not permitted or desired. The French device of three propellers thus came in almost as a necessity, and certainly as solving a difficult problem, and shafting for 7,000 horse power was easily procurable.

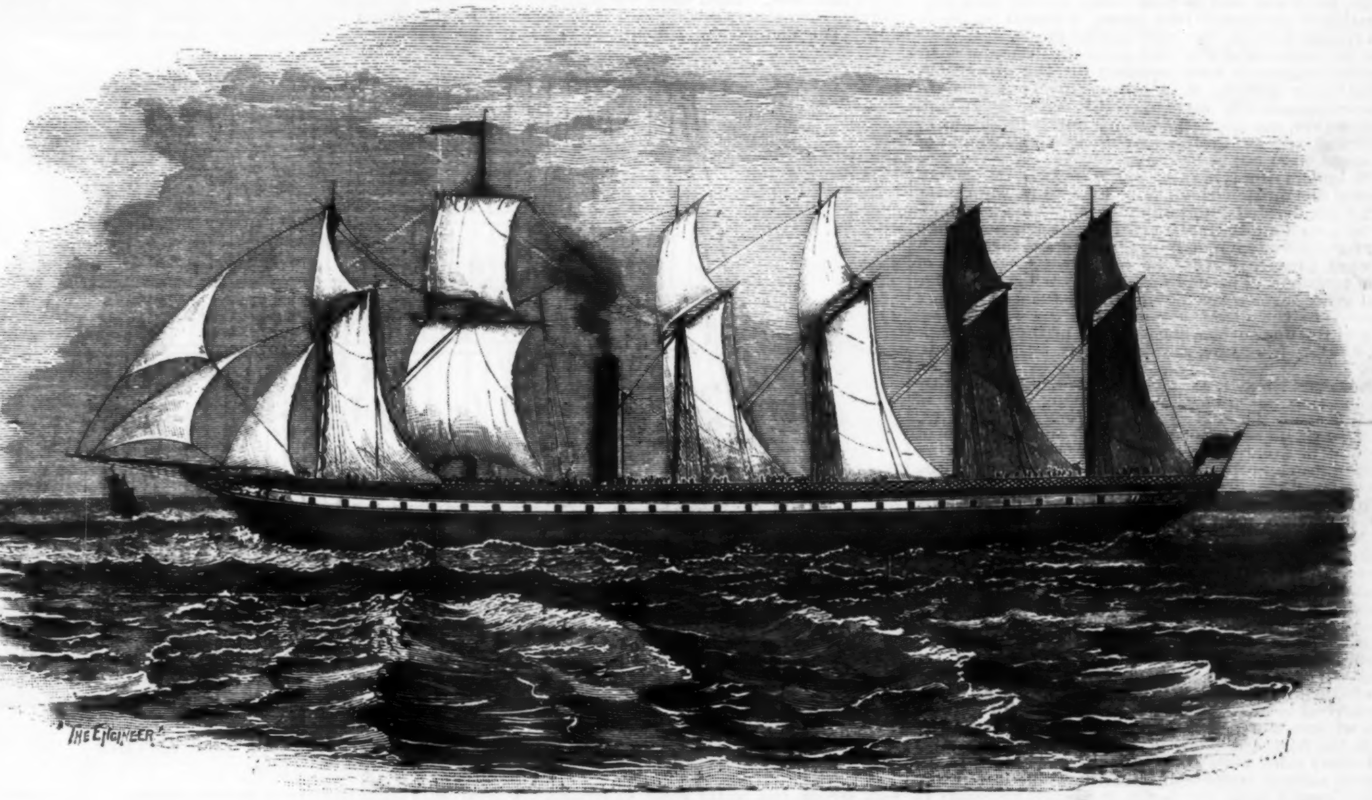
But in selecting this system under such circumstances all other advantages, of course, had been acquired for the Columbia which were sought in the original introduction of that system elsewhere. In the first place, the risk of wholly disabling such a vessel by an accident to her steam machinery is greatly decreased. She has three separate triple expansion engines, each actuating its own shaft, and the chance of all being rendered useless and the ship helpless is seen to be much less than with two screws. The disaster which once befell the City of Paris impressed engineers with the importance of this point, and it applies to the merchant as to the naval service. The smaller size of the shafting and other parts of the machinery also allows higher aggregate speed to be employed with safety.

Again, economy in cruising is promoted by this arrangement. A triple-screw vessel can run with her central screw and one-third power, or with her two side screws and two-thirds. It is found more economical to run with one screw and full power than with two at only partial power. It is perfectly easy to disconnect any of the three screws, each being fitted with a disengaging coupling, and then it causes very little drag or resistance to the progress of the vessel.

A third point of importance is that in triple screws there is a decided economizing of power and gain in speed, in rough weather, when the vessel is heavily rolling. The central screw is especially sure to be immersed under all conditions. This is an advantage which a triple-screw vessel would have in trying to overhaul a twin-screw vessel of equal engine power, and her counterpart in other respects, in a heavy sea.

Naval Constructor Wilson once explained more fully the advantage last spoken of in noting that in the great transatlantic liners "comparatively slow-moving machinery is fitted, and these in turn require propellers of larger diameter. To obtain the necessary clearance from the hull these screws must be brought out and upward, bringing them near the load line; consequently, when the vessel is rolling and pitching, they race considerably, causing a large reduction in the speed of the vessel. In our new cruisers, Nos. 12 and 13, however, machinery of much greater piston speed is used, owing in a measure to its being divided into three parts instead of two. As a consequence, the diameter of the screws is largely reduced, giving them good immersion, especially to the central screw, which will be immersed in almost all conditions. This would tell greatly in a chase after a liner whose screws might be racing." While this view is especially applicable to the Columbia, that part of it which relates to securing the immersion of the propellers would apply also to merchant vessels.

In the SCIENTIFIC AMERICAN for November 1, 1873, will be found illustrations of the circular Russian war ship Novogorod, which was provided with six screw propellers. This vessel, designed by Admiral Popoff, had a displacement of 2,783 tons. She was intended as a floating battery, but proved to be a fair sea boat. Her power, however, was small and she never figured prominently in the Russian navy.



THE STEAMSHIP GREAT BRITAIN, 1845.

THE FIRST ATLANTIC SCREW STEAMSHIP.

As the "Atlantic Ferry," one of the great water highways of the world, is from special causes in this year of grace one thousand eight hundred and ninety-three attracting a large share of the traveling public's attention, the time seems fitting at which to put before our readers some facts in connection with the "opening" of that ferry to steam traffic, and to show how our predecessors in the shipbuilding and engineering arts overcame the want of previous example in the construction of the first—from a practical point of view—successful Atlantic screw steamship, the—at this distant date—ancestor of the Lucania.

Tracing effects to their causes, the construction and completion of the railway between London and Bristol, now known as the Great Western, was the proximate cause of an idea then entertained by a few of its proprietors and directors, that a direct line of communication by means of steamships between New York, as the focal point of the new world, and the city of Bristol, might be established with advantage.

The keel of the Great Britain was accordingly laid in July, 1839, in a dock excavation adjoining Cumberland Basin, Bristol, the entrance to which was closed during her construction by a large caisson, and she was so far advanced toward completion as to be launched, or rather floated, in the presence of his Royal Highness Prince Albert, on the 19th July, 1843.

The following were the principal dimensions of the Great Britain: Length over all, 322 ft.; between perpendiculars, 289 ft.; extreme breadth, 50 ft. 6 in.; depth, 32 ft. 6 in.; displacement at a load draught of 18 ft., 3,618 tons. Her keel was made of flat plates, $\frac{7}{8}$ in. thick and 20 in. wide, welded into lengths of 50 ft. to 60 ft., scarf-jointed, and the joints riveted all over, the forward and after end pieces being 1 in. thick. The stem was an iron forging 12 in. deep and 5 in. thick at the forefoot, diminishing gradually to $1\frac{1}{2}$ in. at the upper deck, the stern or screw frame being also an iron forging. The frames or ribs were angle iron bars, 6 in. × $3\frac{1}{2}$ in. × $\frac{5}{8}$ in. thick, spaced 18 in. apart amidships, but increasing to 24 in. at the ends, where 6 in. × $2\frac{1}{2}$ in. and 4 in. × 3 in. angle bars were used. The outside plating plates were 6 ft. to 6 ft. 6 in. long, 3 ft. wide and $\frac{11}{16}$ in. thick for the garboard and three adjoining strakes, and above these up to the load line the plating was $\frac{5}{8}$ in. thick amidships, tapering to $\frac{3}{8}$ in. at the ends, to lighten them. The vessel had no outside keel proper, but was fitted with two bilge keels—one on each side—110 ft. long, disposed about midway in her length, their under edges being made level with the middle line keel plate. The arrangement of the outside plating was what is known as "clinker built," or with the longitudinal seams lap-jointed, in preference to being "carvel built," or flush-jointed, as was first adopted in iron shipbuilding; experiment having proved that of the two methods the lapped joint was much the stronger. All the seams or joints of the outside plating throughout the ship were double riveted, taper liners being fitted on every frame between it and the outside plate to insure a firm connection between them when riveted up. The butt joints of the plates, which were arranged to come between two frames, were covered inside the ship with tee-shaped butt straps of plate iron, double riveted throughout, the rivet heads outside being flush with the plating.

Internally the ship was divided into compartments by five water-tight iron bulkheads; the first, commencing from forward, separating the forecastle and fore peak from the fore cabin and hold, was made specially strong; the second divided the fore cabin from the engine room above, and the fore hold from the fore stokehold below; the third was the after engine room bulkhead, through which the thrust shaft passed into the tunnel. These three bulkheads were carried up from the ship's bottom to the under side of the upper deck. Beyond the after engine room bulkhead were two others, one separating the after athwartship coal bunker from the after cargo hold, and another at the stern, at the end of the screw shaft tunnel, these latter two being carried up to the under side of the saloon deck only.

The deck beams were made of angle bar iron 6 in. × $3\frac{1}{2}$ in. × $\frac{1}{2}$ in. thick, with their ends bent down and riveted to the ship's frames on either side. Upon them stringer plates 3 ft. wide were riveted, and formed a horizontal tie at each deck, angle iron struts being fitted at each end of every deck beam and riveted to it. The upper and lower cargo decks were of plate iron, the latter being carried on plate iron sleepers on edge running fore and aft through the hold on the top of the ship's frames, stiffened and kept in position by angle iron bracketing riveted to frames and sleepers as shown. Wooden pillars or stanchions, having their lower ends secured to the lower cargo deck, gave support to the upper cargo deck beams, whose ends were secured to the ship's sides, where struts and a fore-and-aft tie plate running the whole length of the deck gave support and stiffness to it.

As seen in our view of the ship under full sail, the vessel's spar or upper deck was flush from end to end, there being no deck erections beyond the ordinary companion hatches over saloon, cabin and engine room stairways; stanchions, surmounted by hand-railing and interwoven with netting running right round the ship, doing duty as bulwarks. The upper deck was of red pine laid lengthwise, the deck stringers being of plate iron 3 ft. wide and $\frac{1}{2}$ in. thick, on the top of which a tie of Baltic pine timber running the whole length of the ship was laid, scarfed together in lengths and bolted to the tops of the frames and to the stringer plates on each side of the ship.

The fourth or lower deck of all was appropriated to cargo, of which the ship could carry 1,200 tons measurement, besides 1,000 tons of coal.

The propelling machinery of the Great Britain consisted of a pair of direct-acting engines, each having two cylinders 88 in. diameter, with a piston stroke of 6 ft. Steam was distributed to each of the cylinders by a piston valve 20 in. diameter actuated by a single eccentric, the steam being cut off from it by means of an expansion valve fitted on the side of the main slide valve jacket.

The main crank shaft was of wrought iron, 17 ft. long, its diameter at the middle part being 28 in., and at the bearings, which were 30 in. long, 24 in. Through this shaft, its cranks, and crank pins, a hole was bored through which a stream of cold water was constantly injected to keep the main bearings cool. Upon this main shaft was keyed a toothed drum, 18 ft. 3 in. in diameter at the pitch line and 38 in. wide, around which, and a lesser drum 6 ft. diameter, keyed on a shaft immediately below it, four sets of pitch chains worked, the motion of which was remarkably smooth

and noiseless, accounted for by the fact that what served the purpose of teeth in both drums were bars of teak wood in the larger and lignum vitæ in the smaller, let into recesses formed in the rims of the former and the boss of the latter. Each set of pitch chains consisted of two links and three links alternately; the sectional area of the four chains being 24 sq. in. The links were first forged, then heated to redness, and each stretched $\frac{1}{8}$ in.; when cool they were bored, planed, and casehardened. The engines being intended to be driven at a maximum of eighteen revolutions per minute, the drums were speeded to give nearly three revolutions of the screw shaft to one of the engine shaft.

The thrust or effort of the propeller was received by a steel disk or plate 2 ft. diameter, against which a gun metal disk of similar diameter, pinned to a collar on the shaft's forward end, pressed, a stream of water admitted to a recess in the center of these disks giving satisfactory lubrication. The thrust block or bearing, carrying the forward end of the smaller drum shaft, was firmly attached to the engine framing, the pressure on it being taken up by wrought iron trussing built into the body of the ship.

The screw propeller fitted to the Great Britain was of wrought iron, with six arms, upon the extremities of which were riveted palms of plate iron 4 ft. 3 in. long on their outer edges and 2 ft. 10 in. deep, with a thickness of $\frac{3}{8}$ in. Its diameter was 15 ft. 6 in. and the pitch 25 ft. The area of all the palms was $56\frac{1}{4}$ sq. ft.; the projected area 47·4 sq. ft., and the part of the arms within the inner edges of the palms 26·88 sq. ft. To reduce the frictional resistance of the blades in their passage through the water, their working or driving faces were planed, painted, and varnished.

The rudder fitted to the vessel was on the balanced principle. It was made of wrought iron plates riveted to an iron frame of the required form, provision being made in this frame for the rudder post, around which the rudder turned, the post being made of the form shown, its lower end or heel being carried by a prolongation of the vessel's keel plate, stiffened by angle bars riveted to it on its under side as shown.

In the absence of a precedent in the design of such powerful engines as were required for the propulsion of the Great Britain, it is noteworthy that even in those comparatively early days of ocean steamship construction, the requirements for a due provision of structural strength in the machinery compartment of the vessel were not overlooked.

The boilers supplying the engines with steam consisted of one outside shell, 34 ft long, 31 ft. wide, and 21 ft. high, divided internally into three distinct boilers by two longitudinal partitions. Each boiler had four furnaces at each end, or twenty-four furnaces in all; each furnace having its own distinct course of flues, terminating in one uptake in the middle. The total grate surface was 360 sq. ft.; the furnace surface exposed to the direct action of the fire was 1,248 sq. ft.; and the flue surface consisted of 1,608 sq. ft. of upper, 6,504 sq. ft. of side, and 1,740 sq. ft. of bottom surface.

The Great Britain, as she is depicted in our engraving, showing her under full sail leaving the mouth of the Mersey on her first voyage to New York, was fitted with six masts, all of which, with the exception of the main or square-rigged mast, were capable of being lowered into a horizontal position, or level with the line of the upper deck.

This leviathan—as she was then considered—took her departure ftom Liverpool on her first voyage to New York on the 26th July, 1845. Her leave-taking was made the occasion of great rejoicing, the Mersey and its banks being quite *en fete*, and the expenditure of powder and lung power in saluting and cheering her as she passed out to sea was something considerable.

After a passage of nearly fifteen days, which was not marked by any special incident worth recording, the Great Britain arrived safely at New York, her average speed during the run out being nine knots an hour. Her arrival in New York harbor was an event to those who witnessed it never to be forgotten. Every vessel in the port and point of vantage along the river and quay sides were covered with spectators in the highest state of excitement, and when she was eventually hauled into her berth, it became necessary to use some degree of force to prevent her being taken entire possession of by the crowds who were anxious to get a first inspection of her.

After remaining on view about a fortnight in New York harbor, the homeward passage to Liverpool was successfully accomplished, and it was a matter for remark on docking the ship for examination that there was not the slightest fouling of the iron plates of her bottom. On the 27th of September she again left Liverpool for New York with 102 passengers and a large cargo on a voyage which was full of incidents; the results of which proved conclusively that a three or four-bladed propeller was a decided improvement on one of six blades, and that without any propeller at all, the Great Britain was a triumph of naval architecture as a sailing ship; and that for safety, speed, and comfort she was in her day unsurpassed.—*The Engineer.*

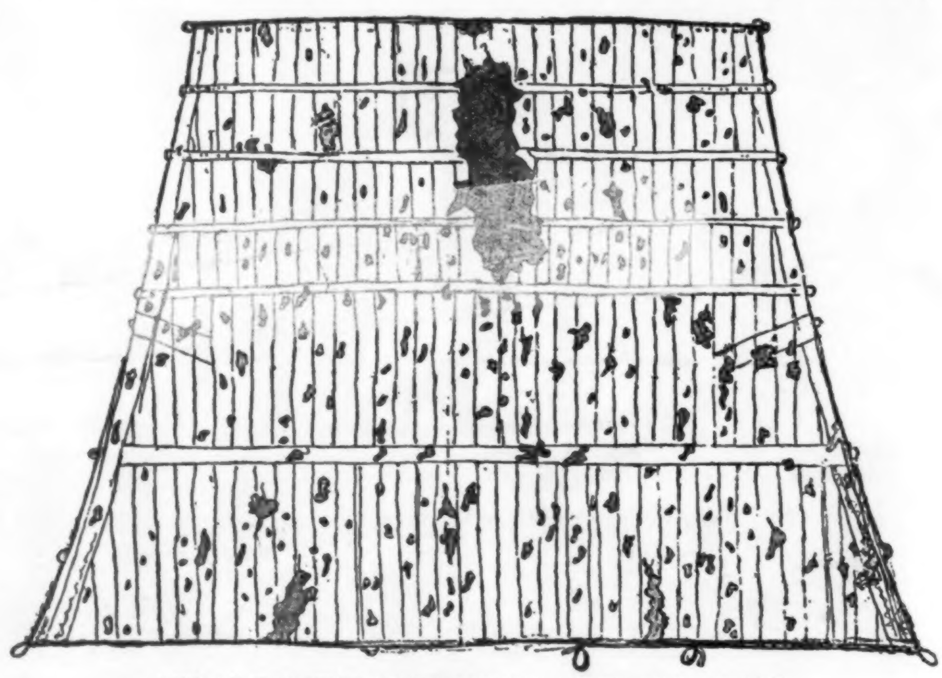
TRAFALGAR, OCTOBER 21, 1805.

Lord Nelson came up early, soon after daybreak, in excellent spirits, and expressing great pleasure at the certainty of being able at last to deal a fatal blow to the enemy he had faced so long. "I shall not be contented," he declared to Captain Hardy, "with less than twenty of them." One of the first things he did was to signal for Blackwood to come on board the flagship. Blackwood found Nelson, as he described, "in good but very calm spirits. His mind seemed entirely directed to the strength and formation of the enemy's line, as well as to the effects which his novel mode of attack was likely to produce."

By eleven o'clock the British fleet had come within four miles of the enemy. The weather column, Lord Nelson's, was perhaps the better closed up of the two, the ships in that line sailing more evenly than those astern of Collingwood. Looking out toward the enemy the scene was superbly grand, as stirring as the heart of British seamen could wish for. Right ahead, stretching north and south for five long miles, almost at right angles across our course, lay the thirty-three men-of-war of the combined Franco-Spanish fleet, under top and top-gallant sails, with maintopsails shivering, heading a point or so off the land. The noonday sun shone brightly on their sails, and all looked as fresh as paint could make them.

Half an hour later Nelson ordered his famous signal to be made. The admiral was walking on the poop with Blackwood, when he suddenly turned to the captain of the Euryalis with "Do you not think there seems a signal wanting?" Blackwood answered, "No; nothing more was needed. The whole fleet clearly understood what they had to do." But the admiral had made up his mind, and as Blackwood spoke, stepped up to his Flag-Lieutenant Pasco, in charge of the Victory's signals. "His lordship," said Pasco, telling what passed, "came to me on the poop, and after ordering certain signals to be made, about a quarter to noon said, 'Mr. Pasco, I want to say to the fleet, "England confides that every man will do his duty."' He added, 'You must be quick, for I have one more to add, which is for close action.' I replied, 'If your lordship will permit me to substitute "expects" for "confides," the signal will soon be completed, because the word "expects" is in the vocabulary, and "confides" must be spelt.' His lordship replied in haste and with seeming satisfaction, 'That will do, Pasco, make it directly.'"

A few minutes later the enemy opened fire, first on Collingwood's Royal Sovereign, which by Nelson's prearranged plan of attack was leading down on the center of the combined fleet, far ahead of the rest of the two fleets, and then, some twenty minutes later, on the Victory herself, as she came within the limits of point blank range. The flagship was just six hundred yards from the Franco-Spanish line, when suddenly a flash, followed by a jet of dense white smoke, spurted from the maindeck battery of a large French two-decker, with a tricolor vice-admiral's flag at the fore, that was just astern of the big, red-straked Spanish four-decker Santissima Trinidad. The shot—evidently intended to try the range—fell short a little way off on the Victory's port bow. Then there was a pause. Just three minutes later came a second shot from the same French ship. The Victory had got nearer, and this time the ball struck the water close alongside. A third shot followed quickly, which went overhead; then a fourth, which also missed, and then a fifth, which tore a hole in the main topgallant sail. That gave the range, and at once, as at one word of command, eight ships together thundered out their broadsides from more than two hundred guns.



ONE OF THE VICTORY'S TOPSAILS AFTER THE ACTION.

There was no more pause or uncertainty about the range now. While yet five hundred yards off the Victory's mizzen topmast was shot away; then her steering wheel flew in pieces, smashed in by another shot. Another struck down Nelson's secretary, Scott, just as he was speaking to Captain Hardy. Presently a big double-headed 36-pounder bar shot, probably from the Santissima Trinidad, came smashing into the squad of marines drawn up on the poop, killing eight men on the spot. After that another cannon shot passed between Nelson and Hardy, carrying with it a splinter that tore the buckle from Hardy's shoe and bruised his foot. At length the Victory approached the point in the enemy's line Nelson was steering for, where the Bucentaure, the French flagship, lay. The ships round the Bucentaure had been fast locking up across the Victory's bows, with the idea, if they could, of blocking out the English leader. Just a narrow gap wide enough to admit one ship showed itself, however, and this Captain Hardy pointed out to Nelson. "I don't care," said the admiral, "it doesn't signify which we run into; go on board which you please."

Hardy went ahead, the Victory pushing past under the stern of the Bucentaure, close enough for a hand from the British quarter deck to grasp the Bucentaure's ensign. As she slowly swept by, first the port carronade on the Victory's forecastle crammed with a 68-pound shot and a keg of five hundred bullets to back it up, was let fly right into the French ship's cabin windows, and then, gun by gun, as each bore, the Victory's whole port broadside followed, fifty-two guns all told. Drifting off, utterly disabled, and heeling over with a deep list, the Bucentaure was practically by that one broadside put out of action for the day. The Victory cleared the Bucentaure, receiving a hot fire from the French Neptune as she forged ahead; but, giving no heed, she discharged her starboard broadside into another French ship, the Redoubtable, into which, putting her helm hard-a-port, she then proceeded to run, swinging close alongside and grappling fast. Thus they fought it out, the Frenchmen with musketry from their tops, the British flagship with her broadside guns, and the rest of the story all the world knows.—*The Graphic.*

[From Engineering.]

BALL BEARINGS.

The use of balls to give an anti-friction bearing is of course a very old device, but until the bicycle brought them into use they had a very small application. The reason of this is not difficult to understand. In order to get a good ball bearing several points have to be secured, otherwise the bearing may be worse than an ordinary one. In the first place, the balls must be absolutely of one size in order to secure the best results, otherwise the work is unequally distributed; secondly, balls must be quite spherical; thirdly, the material from which they are made must have the physical properties necessary to stand the excessive wear and tear. In bicycles, the introduction of ball bearings was preceded by that of roller bearings, in which cylinders were used in place of spheres, and for a long time the rollers were preferred by many riders on account of their greater accuracy; it being naturally far easier to turn a series of uniform cylinders than a series of uniform spheres. Improvement in the manufacture of balls, however, gradually led to the ousting of the roller bearing; and to such perfection has the production of steel spheres for ball bearings been brought that a broken ball is almost an unknown circumstance where the very best descriptions are adopted. We have lately paid a visit to the works of the Auto Machinery Company, of Coventry, an establishment which has been started solely for the purpose of making steel spheres for ball bearings. These bearings are now being used for other purposes than bicycles and tricycles, the perfection to which the design and manufacture of ball bearings have been carried having made possible the application of the device to many purposes of engineering construction where it was previously impossible; indeed, the Auto Machinery Company are now making balls for bearings up to as much as 2 in. in diameter. There can be no doubt as to the advantage of the ball bearing for nearly all purposes, supposing the balls can be made to stand. The Auto Company say that the best anti-friction bearing is one which has its spherical rollers or balls so interposed between the bearing surfaces that the only friction existing is that caused by the point of contact of each ball with its neighbor. Our illustrations, Figs. 1 and 2, represent a section and side elevation of the bearing that has been designed to meet this view. The figures represent the bearings of a dynamo which we recently saw at work, and which certainly ran with remarkable smoothness, at a speed of over 1,000 revolutions a minute, for a considerable time without a sign of heating. When ball bearings were first introduced for cycles, the balls were made of casehardened iron, naturally an unsuitable material, as the casehardening must have rendered the task of finishing the balls truly spherical almost impossible. The grooves in which the balls ran were also badly designed, as they were turned to fit the balls, and there was therefore a considerable amount of friction. Steel was afterward introduced, but it was not of the best quality. In spite of these disadvantages, the use of ball bearings was found a great improvement in the running of bicycles, and by a course of natural selection due to taking out broken balls as they occurred, at last the rider might get a fairly good bearing. The Auto Machinery Company claim, however, to have reduced this matter to a state of certainty, so that natural selection is no longer necessary. We now propose to describe the method by which the balls they produce are made.

Fig. 4 is a general view of one of the most recent types of ball turning machines, while Figs. 5 and 6 give the details. By means of these machines, a straight rod of iron or other metal, slightly larger than the size of the balls to be made, is cut up into a series of balls which are true spheres. Up to the present the company has made balls from $\frac{1}{8}$ in. to 2 in. in diameter,

but so much success has been attained with these sizes that it is expected that considerably heavier bearings, requiring larger balls, will be ultimately made. The wire or rod from which the balls are made is of the best crucible cast steel of the closest grain; it is generally known as diamond steel, and costs, we understand, about 90*l.* per ton. Great care has to be taken in the hardening, but to this point we shall refer later.

The machine illustrated is automatic in its action, the wire only requiring to be placed in when a new length is used; one girl attends to six of these machines, and when a length of wire has been used up, the machine throws itself out of gear automatically. The mode of action is as follows: The machine has a way one-half of two adjacent balls is made at one cut. Both these operations are performed by stationary cutters, and the wire is then fed on another stage, so that the roughly turned ball, not quite separated from its neighbor, is brought under a rotating crown cutter. As this turns round, and the ball turns at the same time, a sphere is produced. This cutter does not, however, go right to the axis of the wire, and the balls are thus left attached to each other. The next operation is to separate them, and for this the wire is fed forward another step. The balls are cut off one by one, also by means of rotating crown cutters, and as they are separated they fall into a receptacle, to be taken away for further operations. In the shop there are 150 of these machines at work.

same temperature, neither too hard nor too soft. An American gas furnace is used for heating, the blast being obtained by a fan. It has been found best, in order to get the right temperature, to trust to the eye of a skilled operator, with a special aptitude for the work, and to assist him in his work the hardening room is always kept in a uniform state of illumination. When the steel balls have been properly heated, they are thrown into a large tank of water. After this they are ground again, the final operation being conducted with great care to bring them to the exact size. The last operation is the polishing, which brings the balls up to a very beautiful surface; it is performed by means of wooden laps, consisting of beechwood, placed endwise of the grain, rouge being used as the

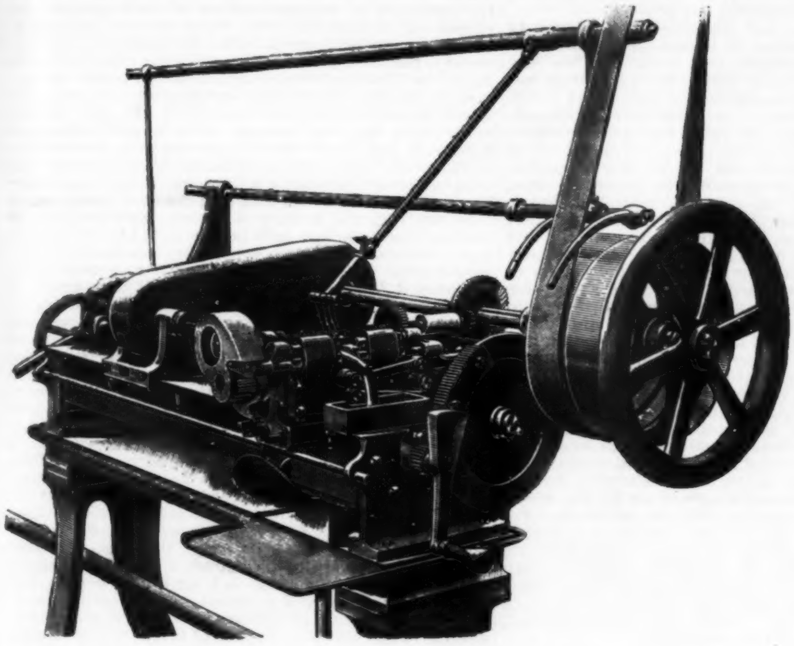
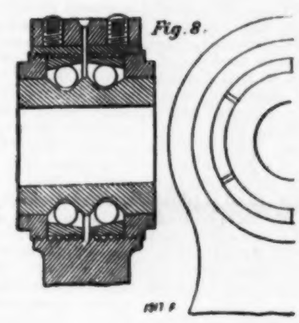
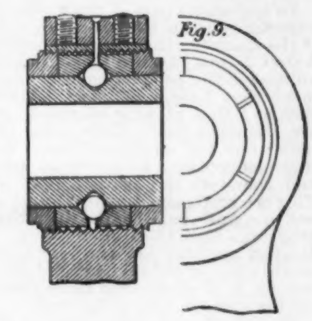
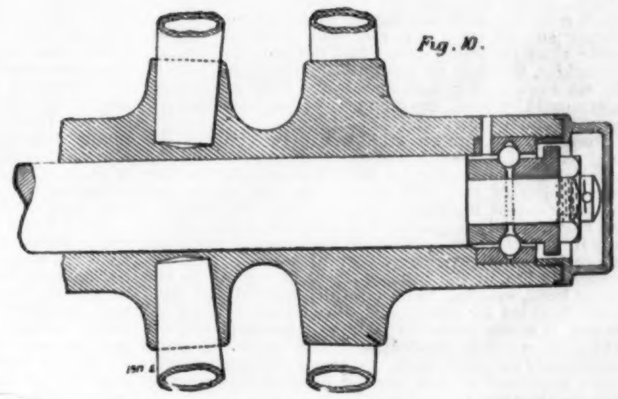


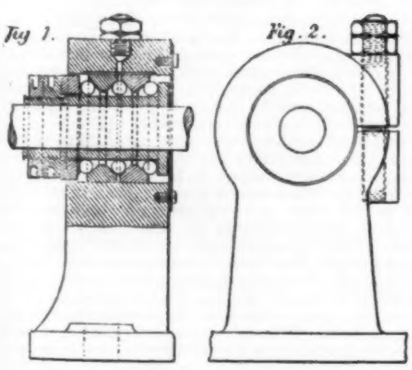
FIG. 4.—BALL TURNING MACHINE.

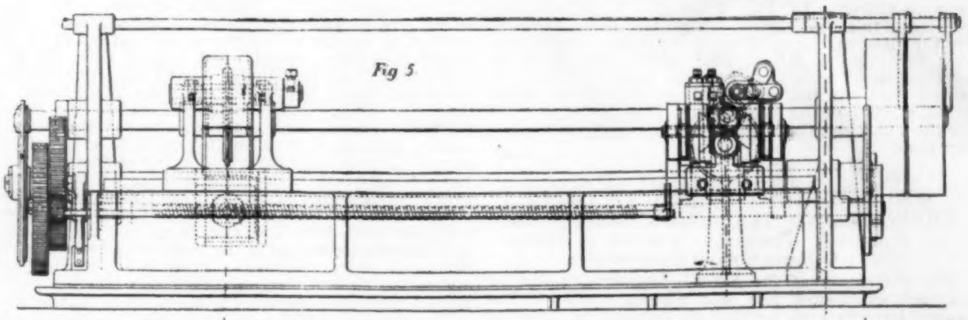


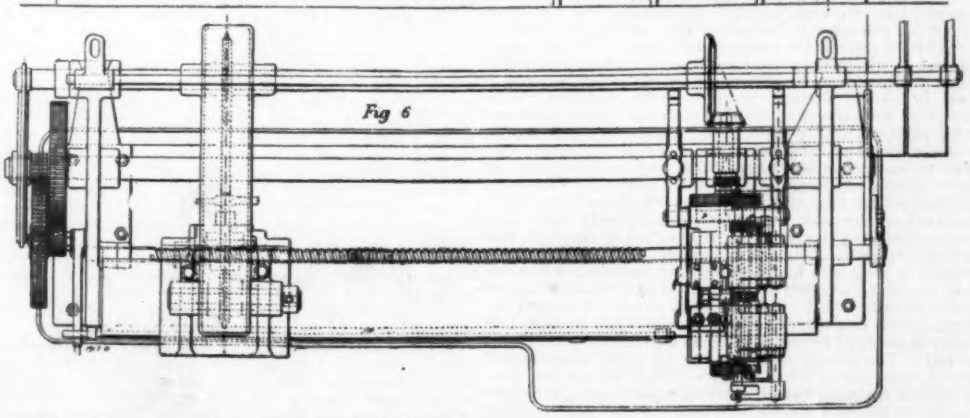


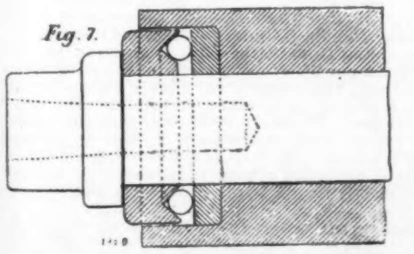


BALL BEARINGS.









MANUFACTURE OF BALL BEARINGS.

hollow mandrel, through which the wire is passed, and there is a traversing head stock which feeds the metal up to the cutters, the latter having no longitudinal motion. The head stock is fed up in this way by a long screw placed beside the bed, and this leading screw is actuated by a toothed quadrant mounted on a disk, and arranged to engage with a pinion on the end of the leading screw. In this way, at the time the wire is fed up so as to bring a new section to the cutters to form another ball, the teeth of the quadrant engage with those of the pinions: of course at that time the cutters are withdrawn, and the cutting operation is suspended. The cutting operation itself is in four stages, carried on by four sets of cutters. The first thing done is to turn a neck in the wire; when this is finished the wire is fed on, and by another cutting tool the neck is made into two half circles by means of one cutter shaped for the purpose. In this

The balls are turned out by the machines just described to within $\frac{1}{1000}$ of the finished size. They are next taken to the lapping department, where they are ground to an accuracy of $\frac{1}{5000}$ in., by means of cast iron laps with grooves turned in them. It is, of course, necessary to keep these grooves accurately to size; that is to say, they must be turned to a curve of the proper radius, for the grooves are not complete half circles; if they were, it would be necessary that the two laps should meet. The laps are constantly being tested by gauge, and are turned immediately any variation from the standard size is discovered. A lap will last about three months, but during that time the groove has constantly to be turned down. The material used in lapping is powdered emory and a hydrocarbon oil.

After the balls have been ground in this manner, they are hardened, and this process has to be conducted with great care, so as to get all balls of the

polishing material. These laps run 1,500 revolutions a minute.

During the process of manufacture, the balls are tested by automatic testing machines, these consisting of two bars of hardened steel, placed a given distance apart. The final testing, however, is the principal one, and is an operation of some magnitude, the testing room being quite a large place, containing a good many machines. In the first machine steel bars are placed a distance apart not greater than the required diameter of the balls. All, therefore, that are too large do not pass through, but roll down the bars, which are slightly inclined for the purpose, into a box placed for their reception. The machine will in this way search out balls that are half of a thousandth part of an inch too large, allowing balls that may be of the exact size or too small to pass between the bars into a receptacle placed below them for the purpose. In this

way all balls that are too large have been disposed of, and it now remains to eliminate those too small. In the next machine the bars are placed half of a thousandth part of an inch closer together than the required diameter of the balls; therefore balls of the exact size, within the limits assigned, are retained, while those too small drop through into the box beneath. The operation may be divided up into several stages, so as to get a gradual and more accurate sifting, but the limit of error given is $\frac{1}{2000}$ in. The testing instruments have naturally to be very carefully looked after, and they are tested constantly by means of a micrometer gauge. After this a microscopic examination is made of every ball in order to discover flaws that may exist, and which are at once revealed by means of the polishing.

An important part of the works—perhaps the most important—is the tool room, for it is on the accuracy of the machines that the work produced depends. The Auto Company make all their own machine tools—*i. e.*, all used in the production of balls—and in this department they have some very beautiful machine tools, such as lathes, planing machines, etc.; many of these are American productions, some of them very costly tools; but the additional price, we are told, is more than compensated for by the accuracy of the machines, and, therefore, the perfection of work they turn out. This is a statement we hear more often than is pleasant in connection with the finer kinds of machine tools that come from the United States. It is a matter that English machine tool makers might well turn their attention to. It should be stated that the steel used for cutters is of exactly the same description as that used for the manufacture of the balls.

The number of balls made at these works is about 80,000 a day, mostly, of course, of the smaller sizes, although, as stated, the larger sizes are fast coming into requisition. The success that has attended the manufacture of balls is chiefly due to the extreme care taken in their production, not only in the process of manufacture, but in material. As the Auto Company point out, it is of the first importance that all the balls in a bearing should be of one size, and if one be $\frac{1}{1000}$ in. larger than its fellows, that ball not only sustains all the weight, but has to push all the remaining balls of the set round. For high speeds and light loads small balls should be used, the diameter of the balls increasing with the load.

From what has been said, it will be seen that the chief secret of success in ball bearings consists in the material used—not only for balls, but also for the settings—being of the best quality, so that the proper combination of hardness and toughness is obtained, and this can only be got by best crucible steel. Accuracy in manufacture is obtained by means of machines of precision and extremely careful gauging; while a proper design in the bearing itself in regard to the size of balls, etc., has to be carefully worked out from data obtained by experience; these points being observed, it seems probable that ball bearings will obtain a much wider application. The Auto Company has already supplied them, for many engineering purposes, to several of the leading firms of this country and the Continent.

In conclusion, we may refer to some of the various types of ball bearings produced at the works we have been noticing. In Fig. 7 we give a section of a bearing to take end thrust, which has been designed for a drilling machine. Figs. 8 and 9 show ball bearings for engines, lathes, etc.; while Fig. 10 is an application of balls to a carriage axle. It may be stated that the list price of balls runs from about 2s. 6d. a gross for the ⅛ in. balls up to about 84s. a gross for the 1 in. sizes, the cost increasing rapidly as the size increases.

[Continued from Supplement, No. 934, page 14921.]

TECHNOLOGICAL SCHOOLS: THEIR PURPOSE AND ITS ACCOMPLISHMENT.*

By Robert H. Thurston, Director of Sibley College, Cornell University.

The Curricula of the Schools furnish a subject for constant discussion, not only among educators, but among parents and pupils. In relation to those of the "culture schools," those of the scholastic character, which have grown into shape from the monastic period in which they originated, and under the influence of that form of culture which they are intended mainly to perpetuate, there is little question. The purpose and method of the classical education are well defined and settled, from primary school to university, but the later scientific and mixed schools, and the technical school, have a less well defined form, as they have a less exactly prescribed purpose. Were we permitted to organize the ideal school and system of education, the task would be comparatively easy, and we should lead the pupil of the primary through the secondary school into the college and university—finally giving him his professional training, after he had acquired as good an education as time and means may permit. But even at this advanced period we find, often, less than one-half the students in our law schools holding college diplomas and already well educated. The young man seeking to enter a profession must, very often, if not usually, either secure his professional training before entering upon a college course or not at all, and we cannot shut out the best youth of the country from the professions because, not having inherited wealth, they cannot first secure a liberal education. If this proposition be correct, we find a reason for the fact that the professional schools, as a rule, demand of their entering students only that preparation which is essential for the successful prosecution of the professional studies. It is, at the same time, well understood by all that the possession of a liberal education is, in the highest degree, desirable, and every young man of sense and ability seeks as much of this great good as his circumstances permit.

The great problem which confronts the educators of this country is thus to so organize their school systems that the sons and daughters of well-to-do people may pass by a regularly graded course from primary to secondary school and on into college, and, if they choose, into the higher work of the university; while the children of parents less favored by fortune may similarly pass from secondary school into the professional or the trade school, and even, in the case of the poorest, from primary into trade school; the latter in this case becoming the secondary or high school, beyond which these pupils cannot afford to go. In each school, the ideal method and plan is marred by the practical conditions of life. In each school two, if not three, classes of pupils are to be cared for. The primary school, only, prepares all alike; the secondary school completes the education of the poorer and gives the children of the wealthy only the first step in their preparation for the higher education which they are to be given later. Its work may even be that of a trade school as well. The college, similarly, may be required to educate the youth, in one case, for a professional school, in another for the world, in another for the work of the university, in the highest fields of research in science, in literature, in art.

The professional school of whatever kind obviously can do its best work when it makes professional instruction its whole purpose and work. "This one thing I do," is the motto in education as in business; both because it is by concentration that most is accomplished and because it presupposes the best preparation that the student can give time and means to secure. That law school, that school of medicine, or of engineering, which gives its whole time to professional work, and employs specialists for the whole list of studies thus given, will be able, as a matter of course, to do the most and best work in the time allowed it. It will, other things equal, have the best prepared and most mature students, and be thus able to cover most ground with its special curriculum. This is one of the notable features of progress during the generation in our representative scientific and professional schools. All are moving their requirements upward and eliminating the elementary and non-professional work, and offering a larger and larger proportion of the purely professional and characteristic branches. With the engineering schools this progress is accelerated and compelled by the need of higher and higher mathematical preparation; and, with each step in this direction, the student gains in his whole range; the additional time demanded for the increased mathematical preparation being also certain to insure more attention to the languages and the literatures, as well as to the scientific studies of the preparatory schools; which, in turn, are, by this pressure, continually raised to a higher grade. The demand of the school of engineering for higher algebra brings in students familiar with French; the call for solid geometry insures the offering of chemistry and of physics, and the requirement of trigonometry brings in students who have studied, very likely, both the modern languages.

But a large class of students desiring to enter the professional engineering or other schools cannot give time and money to a course of eight years' duration, dating from the termination of their elementary studies at say eighteen, taking first a liberal education and then a professional training. These will seek the school which offers the more essential professional studies, and, with them, so much of general education as can be crowded with them into four years. The majority of our schools, at present, supply this demand, and rarely approximate the ideal type above alluded to. This must probably long remain the fact with most technical schools.

Preparation for the technical schools, or for those which are attaining the rank of professional schools, at least, is settled as to character and extent by the demands of those schools; and they, in turn, are governed and controlled by the conditions of their environment. They require as complete preparation as they can secure from the schools which feed them; the latter give as good a preparation as the circumstances and age of their pupils and their own facilities permit. In neither case is it a matter of choice purely. Each is continually demanding more of the schools below, and forcing, as fast as practicable, schools and pupils alike to higher levels of scholarship. Every influence tends to compel the more and more careful and judicious selection of the work of the whole series of schools, more systematic work in instruction, specialization on the part of school and teacher and of pupil, and higher efficiency in the work of both as well.

The separation of the technical from the purely educational schools has been by many, especially by foreign educators, considered essential to the prosperity of both, and especially in the higher grades, where the curriculum of each is forced to receive much and to reject more of the continually and rapidly widening and deepening current of human knowledge. That their co-ordinate and even mutually helpful operation may be possible is now coming to be seen in the United States, as never before or elsewhere, in the workings of the State universities; but the existence of and the reputation attained by a number of our independent technical schools—higher, in fact, usually, perhaps, than has been reached by the average adjunct university schools—indicates that independence is not necessarily dangerous to success; and the lesser distractions of the latter and the broadening influence of the former may perhaps be by many set off against each other as fairly compensating circumstances.

There exists, among the members of the professions even, a somewhat strong impression, one which, it must be confessed, has some justification in the experience of the past throughout the world, that a technical school cannot be made to succeed fully and satisfactorily as a part of an organization including academic schools; but that, in the presence of these apparently conflicting interests, the school of engineering must suffer, if not absolutely fail. This conviction has been expressed very strongly by President Eliot, of Harvard, and still more so by the German educator, Professor Reuleaux, the head of the great technical university in Berlin, and who is by many regarded as the leader of the profession in Europe. In his address entitled, "Cultur und Tecnik," he says that, "Notwithstanding their intended pursuit of a strictly scientific aim, the technical schools have not concluded their peace with the universities. Even with the best of good will, none of our efforts toward a real amalgamation of the two has ever been successful." He quotes Professor Koechly, who says, "And if not side by side, at least we can fight back to back," in the great contest with ignorance and barbarism. He considers this unfortunate difference as arising from inherent differences in aim, and goes on to say that a blending of the two movements has been tried in the United States, our universities being both classical and technical, but that "the experiences hitherto gathered have not shown, so far as observation permits a judgment, that the union can be permanently maintained, or that it has furthered the interests of education in the way that legislators had anticipated."

"It is a great pleasure to be able to testify that, although the influences tending to produce such differences as are here referred to, do and must, as I think, necessarily, and probably should, exist at Cornell University, there is as yet no evidence that they are to be apprehended as likely to produce permanent effect of evil. It seems more than probable that every officer of the university, understanding clearly its aims, and, as must be evident from the fact of his acceptance of duties in connection with it, approving those aims, the presence of representatives of such a variety of phases of educational work must exercise a conservative and beneficial effect in the development of a university, planned, as is Cornell, with the object of adding to its 'leading' departments every adjunct necessary to enable the student to acquire a thoroughly liberal as well as practical education. To the technical student, frequent contact with liberally educated men, and familiarity with a variety of non-technical work, must bring great advantages aside from the other general liberalizing influences of his university life." (Report of the Director of Sibley College, 1886.)

In studying the history of the rise and progress of technical schools, not only in this country but in Europe, and not only in our generation but in the earlier generations of European history, we may note that, as General Walker once remarked, "The schools of technology illustrate in an eminent degree the law of human progress which I have stated. These schools have not come into existence in obedience to a demand for them. They were created through the foresight, the unselfish devotion, the strenuous endeavors of a few rich men and of very many poor men, known as professors of mathematics, chemistry, physics and geology." They have not become, as he goes on to say, an essential part of the educational system, and he adds: "They are to-day doing a work in the intellectual development of our people which is not surpassed, if indeed it is equaled, by that of the classical colleges;" and further, "in the schools of applied science and technology, as they are carried on to-day in the United States, involving the most thorough and most scholarly study of principles directed immediately upon the useful arts, and rising in their higher grades into original investigation and research, is to be found almost the perfection of education for young men." And again, "That all the essentials of intellect and character are one whit less fully or less happily achieved through such a course of study, let no man connected with such an institution for one moment concede."

In conclusion, and in direct reference to the queries which form the basis of the discussion of the Educational Congress of 1893, at Chicago, the writer may be permitted to submit the following, not as criticisms of existing schools, but as indicating what seems to him the lines of improvement and advancement of our schools and of our systems of education for the immediate future.

(1) Progress is visible toward the organization of one "complete and perfect" system of education in every State, from primary school to State university, which shall be so organized as to offer every citizen, as Huxley puts it, "a ladder from the gutter to the university," and entrance into any one of the existing and of the rising learned professions, into the trades, or into any vocation of work, of leisure, or of self-improvement, that he may be able and willing to choose, and with, perhaps, a national university over all.

(2) The technical schools, from kindergarten to technical school of the university or the great independent professional school, are coming to have more definite curricula, to adapt themselves more perfectly on the one hand to the needs of the people, on the other to the great educational system of which they are to form a part. The higher schools are developing into professional schools, the intermediate grades into trade and mixed schools, the lower and manual training and primary schools with the manual training element descending, in the form of the kindergarten system, into the primary school. Whether, ultimately, the representative school will have a purely technical or mixed curriculum is, of course, as yet indeterminable; but the forces of economical change are working strongly in the direction of steady rise with tendency toward concentration and specialization, from kindergarten to professional school. Yet, as President Walker has suggested: "Possibly some ultimate form for institutions of the higher learning may yet be developed which shall embody much of both the modern school of technology and of the old-fashioned college, with, perhaps, something taken from neither, but originating in the larger, fuller, riper life of a happier and richer future." For the present, the independent schools will probably continue to offer a curriculum containing extra-professional studies. The universities will probably more and more restrict their professional schools to professional work, leaving the student the privilege of either taking his educational course in advance or as contemporary elective work in other departments.*

* Opening the discussion on technical education, World's Educational Congress, Chicago, July 26, 1893, President Francis A. Walker in the chair.

* It is a curious fact that, while the whole tendency in the United States and in other countries is obviously toward the organization of a system of State-supported schools, with a State university at the head, and toward a constantly more and more completely hierarchic form, there has arisen in France, at the very fountain head of this movement, a sentiment favoring the destruction of the whole system and breaking up of the State organization and replacement by local and limited organizations. The system now in operation, as established in 1808, by the first Napoleon, constitutes the Minister of Public Instruction the head of the national organization. He provides for the inspection of schools and colleges conferring degrees, on recommendation by the proper authorities, and the appointment of professors and teachers, and thus controls the whole educational machinery of France. The country is divided into academic districts, each having its special faculty, with a rector at its head, who is assisted by a corps of inspectors; the scheme being in some respects like that of the University of the State of New York, but endowed with a larger scope of operation and greater powers. In each district an academic council has charge of matters of discipline; a faculty of letters attends to the curriculum in its field, and another of science takes charge of that branch; faculties of law, medicine, theology, supervise the work of the professional schools in each of those departments. Of late Jules Simon, Jules Ferry, Taine, and others have proposed the reconstruction of the system in such manner as to produce a considerable number of local systems, corresponding, somewhat, to our own separate State systems, each with its own local university and underlying secondary and primary schools; breaking up the University of France, as the whole is now called, into a collection of independent, but very similar, smaller provincial universities. One reason urged for this change is that the Academy of Paris secures too large a proportion of students; another is that greater independence is thought desirable in the provincial sections and in the large cities outside of Paris.

(3) The universities are establishing, continually, more and more definitely separated schools of culture and of the applied sciences and of the professions, each having its strictly defined place, purpose and curriculum, its exactly prescribed condition of admission to its courses, and employing a staff of specialists to give the instruction which it offers as its peculiar work. The college is confining itself more and more closely to its work of education of the graduate passing into business life, or of the man going upward into the university. The schools are similarly taking defined places in the general system and complying more fully with the demand of the college and the university for good preparation of their entering classes, and of the people for a fitting preparation of the youth passing out from them into the common vocations of life. The independent schools are choosing their work, concentrating their strength and energies, and better and better performing a more and more precisely defined part of the great work.

Organization, systematization, concentration, specialization, union of distinctly separated and different elements into an orderly and complete whole are the striking characteristics of the changes now progressing in our whole educational system. The outcome will probably be the formation of complete State organizations of schools constructed with reference to the needs of a people, from kindergarten and primary school to college and university and professional school, including manual training and trade schools, properly distributed as above indicated to be desirable, and, co-operating with this organic whole, here and there a special school independently doing its chosen work and serving as a stimulus and example to the official school. Washington's great hope—the Washington National University—may, perhaps, ere long take form and secure as its province that of preparation of strong men, of refitting learned teachers and professors for the universities and colleges of the States, and especially of carrying on and promoting research in every field of human knowledge. We have had no real university since the days of the Ptolemies and the foundation of the Alexandrian school. The monastic and scholastic element gave us but a narrow and fragmentary education. The introduction of the sciences during the years since Newton and Gilbert, of the applied sciences since Lavoisier, of the arts since Vaucanson, and of instruction in the constructive professions—besides that offered the older "learned" professions—these have reconstructed the university; and now, as never before for two thousand years past, we have looming up before us the outlines of an all-inclosing educational structure which comprehends the learning and the principles of the whole range of the literatures, the arts, the sciences, of contemporary human development. Of this horizon- and zenith-reaching arch, perfect and complete as it soon may be, culture and learning are the voussoirs, and technical education is the keystone which sustains the whole and its superincumbent burden, the higher life of the people.

Those hundred "Prophetic Voices Concerning America," preserved by Charles Sumner in his remarkable little book under that title, unite in predicting marvelous growth and a wonderful future for the people of the United States—which means, at a not distant future time, at least the continent of North America—but this can only prove true prophecy when the people of the United States and of every State shall have performed their greatest work and their noblest duty by insuring to all their successors the lofty privilege of education, each for his own life, and of systematic training, each for his own chosen work in life. De Toqueville says: "The Americans of the United States, whatever they do, will become one of the greatest nations of the earth."* We may confidently hope and believe that his prophecy will be ultimately fulfilled; but it will come of highest statecraft, not of politics; of real wisdom, not of policy, and only when the "complete and perfect education" of a great people, for the life and work of a great people, shall have fitted it for its final destiny. It is the steady and rapid evolution of this great system of preparation for a grand destiny that we see now progressing throughout the country, and which will soon result in a combination of private, State, and national support of this most substantial of all possible foundations for nationality and life, such as will make safe the accomplishment of that most remarkable of all these predictions:

"Westward the course of empire takes its way;
The first four acts already past.
A fifth shall close the drama with the day;
Time's noblest offspring is the last."†

THE REFINING OF PETROLEUM.

IN a long article describing the exhibit of the Standard Oil Company, at Chicago, contributed to the *American Gas Light Journal* by Mr. McKay, an account is given of the refining process to which petroleum is subjected, and also some information about the resulting products. The following is the description of the refining process: From the crude oil storage tank the oil is pumped to the crude oil still, where it is gradually heated until the naphtha and burning oils are driven off by distillation, and passing through the condenser and receiving house, are collected in three tanks. The burning oil distillates are pumped to a large agitator, where they undergo chemical treatment (with acid and alkali) to render them fit for consumption. The crude naphtha is then redistilled in a naphtha still, giving the various grades of gasolines and naphthas. The tar left after the first distillation is transferred to the tar still, where it is separated into light paraffin oil, heavy paraffin, and still cake, which remains in the still. The light distillate is used for fuel. The heavy oil is sent to the paraffin wax press house, where it is chilled and pressed to remove the paraffin oil, leaving the wax. The cake remaining in the still as a final residue is used in the manufacture of electric light and battery carbons. The reduced still oil is used for the production of lubricating oils.

The Standard Oil Company does not make or sell "kerosene." True kerosene is a product of the distillation of coal; it is "coal oil." Shale oil is a variety of the same substance. It is incorrect to designate as kerosene the illuminating oils produced by the distillation of petroleum; these oils are essentially petroleum distillates, or petroleum oils. There is no more common error than to speak of the oils used in house lamps as kerosene, yet it is extremely doubtful whether any kerosene, correctly so designated, is purposely manufactured in the United States. The quality of burning oils differs according to the State or country to which it is sent. The fire test varies from 110° to 150° in the different States; some States specify by law the colors of the oils that may be sold for illumination. *Oils sent abroad are of a much lower general grade.* During distillation color, weight, temperature, and chemical tests, with time and personal experience, govern the distribution of the distillates; the thoroughness of the treatment of the illuminating oils in the agitator determines their final purity and color.

To return to the distillation of crude petroleum. This subject is illustrated by a series of cases containing products, duly labeled, showing the result of theoretically perfect fractional distillation in the amounts of crude naphtha, burning oil, tar and coke obtained from a barrel of crude oil. The central feature of the general exhibit is described as "a glass case containing a barrel of crude oil, such as is received from the pipe lines." The average specific gravity of this is not far from 45° B.; more than this amount (one barrel of 42 gallons) is actually delivered from the pipe lines of the Standard Oil Company every second of the twenty-four hours of every day in the year. The breaking up of the crude oil is in the parts, 75, 10, 10, and 5, of burning oils, naphthas, lubricating oils, and tar and cake, respectively. The percentage denoting burning oils is exhibited as further separated, as follows:

	Degrees.			Per cent. of 1 barrel of crude oil, before treatment with sulphuric acid.
Standard white..	150	distillate,	representing	29
Standard white..	120	"	"	15
Headlight........	175	"	"	2
Mineral seal.....	300	"	"	1
Water white....	150	"	"	12
Standard white..	110	"	"	10
Water white ..	120	"	"	3
Water white	110	"	"	3

The above list shows how the enactment of State laws, prescribing color and fire tests, enables the intelligent refiner to produce the maximum of the oil locally necessary or desirable. Headlight oil, as its name implies, is used in the headlights of locomotives. Mineral seal is the oil used in lighting passenger railway coaches. If, in an accident, a lighted lamp burning this oil is overturned, the overflow of the oil from the specially constructed reservoir will extinguish the flame and prevent the spread of fire. This oil has a specific gravity of about 36° B. Besides the above samples, showing the distillates before treatment with sulphuric acid and with soda in the agitators, there will be found samples of the same oils, and of intermediate grades, after such treatment and purification. Water white is produced with a little more labor and more care than standard white, but the crucial fire tests may be the same for both. The improvement in color is catering to a special trade.

From the 10 per cent. representing crude naphthas is taken $1\frac{3}{4}$ gallons of light gasoline, and from this, in turn, are obtained redistilled gasolines of gravities 90°, 88°, 87°, 86°, and 76° B. Also from the crude naphthas are taken the heavy naphtha distillate and naphtha still bottoms—left in the still after the distillation is finished. From the heavy distillate come the redistilled naphthas, 58° to 63° B., and the deodorized naphthas, of gravities 61°, 62°, 63°, $67\frac{1}{2}$° to 76°.

An entire case is given to specimens of products, in all stages of the manufacture, from the 5 per cent. representing petroleum tar, or residuum, and cake. The heavy distillates from tar are treated with acid, pressed and yield paraffin oils and crude paraffin wax or crude scale. Samples of these, and of the light distillate, used for fuel, are shown; also samples of hard refined wax, soft refined wax, crude scale, slack wax, zone, red and diamond paraffin oils, foot's oil, gumstock or drippings, pressed oil, and still wax or wax tailings used in the paper trade. Also are shown petroleum cake for electric light carbons, and petroleum pitch or asphalt for paving and roofing. What is known as No. 2 paraffin stock is melted in naphtha or lye, crystallized and repeatedly pressed, yielding small crystals which melt at 116° F., and form the basis of chewing gum—sugar, gum, and flavoring extract being the other ingredients. Under the paraffin division should be included vaseline compounds, which are carefully purified and filtered distillates. A large case exhibits petroleum jellies or vaselines, cerates, pomades, soaps, and face paints.

The 10 per cent. of the original crude manufactured into lubricating oils has no recognizable subdivisions. Wagner states that a pure mineral oil for use as a lubricant must have the proper consistency, must not harden, must not contain any mineral or organic acid, must evaporate and inflame at a high temperature, must show no separation of paraffin under cold, and should have but a faint odor. Paraffin oil that does not boil under 700° Fah. is considered one of the best lubricants for cylinders at high temperatures. Mineral oil, carefully prepared, is used for the lubrication of watches. The market affords the purchaser the widest conceivable choice in the selection of lubricating oils; all grades, all prices, colors, and names are offered. The admixture of animal and vegetable fats is in the nature of an undesirable adulteration, frequently practiced.

As the great bulk of the trade of the Standard Oil Company is in the sale of burning oils, it follows that a lively interest is maintained in the development of satisfactory appliances for the burning of the oil for the production of light.

A leading feature of the exhibit is a cleverly erected pyramid of barrels, at the east side of the section. This pyramid shows the total output of oil for the United States for one day—140,000 barrels in all. The barrels are so painted that the lines of color effectively aid the eye in the endeavor to compare the several volumes. The total product is thus divided up:

Illuminating oils....	105,000	bbl.	=75	per cent. of total.
Lubricating oils.. .	14,000	"	=10	"
Naphtha and fuel oils	20,300	"	$=14\frac{1}{2}$	"
Cake...............	700	"	$=\frac{1}{2}$	"

The several products are indicated by painting the barrels blue and white, red and yellow, purple and white, and black, in the order above given.

ISOCHROMATIC PHOTOGRAPHY.*

By G. CRAMER, St. Louis, Mo.

AMONG the great discoveries and achievements that characterize our present century and have accomplished results never before dreamed of and formerly deemed impossible, photography holds a prominent place in practical utility and as a helpmate to art and science.

Portraiture has been brought to simplicity, and in the fraction of a second we can secure the features of those who are dear to us. Foreign countries and nations are brought to our sight in pictures produced by the camera, movements of animals, too quick to be distinguished by the human eye, are truly and accurately recorded by the highly sensitive photographic dry plate, the stars are photographed as well as the minute bacilli and bacteria, whose multitudes inhabit the drops of water and the cells of animal life, and which, in many instances, are the causes, heretofore unknown, of diseases.

Since photography has rendered it possible to secure the rays of light on the sensitive plate, it has been the aim of scientists and practical workers to bring it to perfection, and the greatest improvements have been achieved in the preparation of dry plates ready for use and of the utmost sensitiveness. The great desideratum, to obtain photographs in natural colors, is now brought within the reach of possibility, as shown by the fine specimens of reproductions which are on exhibition in the photographic department of our great World's Exhibition, and the time may not be far distant when portraits and landscapes will be photographed in all the beautiful tints and colors as seen in nature. The most important step in this direction was the production of color sensitive plates, by which one of the shortcomings of photography is corrected, that is, the insensitiveness of the ordinary plates to the yellow, orange, and red colors, which cause these colors to appear much darker, while the blue and violet appear much too light in the ordinary photograph.

The aim of isochromatic or orthochromatic photography is the production of plates equally sensitive to the different rays of the spectrum, so that in the monochrome of the finished picture all the colors are rendered equally correct in their respective values.

This color sensitiveness is obtained by the addition of certain ingredients, mostly of the eosine group of aniline dyes, to the sensitive bromide of silver emulsion, and the plates so prepared are called isochromatic or orthochromatic plates.

A great drawback to the introduction of the isochromatic plates into general use has been the necessity of a color screen in order to obtain the isochromatic effect. A yellow glass had to be placed before or back of the lens, or a yellow pellicle in place of the diaphragm, to filter the light and to subdue the greater actinic power of the blue and violet rays. The isochromatic effect being increased in the same proportion as a screen of deeper yellow color is used, it necessarily follows that the required exposure is prolonged in the same ratio and to such a degree that the use of a color screen for portrait work and instantaneous exposures is out of the question. If the yellow screen is not perfectly even in structure and thickness, and absolutely plane, it will cause distortion of the image by aberration. Change of chemical focus and reflection may also be caused by its use, and, therefore, it is apparent that plates which produce the greatest isochromatic effect without the aid of a color screen are the most valuable.

As such plates can now be obtained which combine great rapidity with good color sensitiveness, and are no more difficult to work than ordinary plates, their advantages should be appreciated by the photographic fraternity.

In portrait photography blue eyes and auburn hair are rendered more truthfully, imperfections in the complexion, such as freckles, are less noticeable, and dresses of any color are photographed correctly, so that ladies need no longer consult the photographer as to what color of dress to wear when having their pictures taken.

In landscape photography the main advantage of the isochromatic plate is that distant objects are photographed much more distinctly than with the ordinary plates. A slight haziness in the atmosphere is neutralized by the use of isochromatic plates, while an ordinary plate would not produce any satisfactory results under the same circumstances. White clouds in a blue sky cannot be photographed except with the isochromatic plates, and how much clouds add to the beauty of a landscape is known by everybody. In sunset scenes the superiority of the isochromatic plates is apparent, as in the autumn landscapes with their wealth of yellow and orange tinted foliage.

In seascapes and marine views the horizon is not lost, water and sky being properly rendered.

In commercial photography the instances where isochromatic plates should be used are too numerous to mention. Woodwork, which is generally of a yellowish tint, is photographed more perfectly. Inscriptions on wagons, railroad cars, samples, floral designs, etc., which may not show at all when photographed with an ordinary plate, are perfectly reproduced.

Now, for the copying of paintings in oil or aquarelle, nothing but an isochromatic plate should be used, and its advantage for this class of work is most strikingly apparent. In old oil painting the lights are generally yellow, while the half-tones are of a bluish tint. It is impossible to obtain a good copy of such a painting with an ordinary plate. Plates of full isochromatic effect are necessary for this purpose.

Another advantage of the isochromatic over the ordinary plate is its greater sensitiveness when the light is yellow, as is frequently the case in the fall, when the sky is cloudless, or in photographing by gas light.

I have now said enough of the advantages of isochromatic plates, and beg to be excused if I have made statements of facts supposed to be well known; but the isochromatic plate being undoubtedly the plate of the future, it seems to me that its full value should be more generally understood and appreciated.

* "De la Démocratie en Amérique," 1864, t. ii., ch. x., p. 399.

† Bishop Berkeley; Works, vol. ii., p. 443.

* Read at the World's Congress of Photography, Chicago.

STATE AND FOREIGN BUILDINGS AT THE WORLD'S COLUMBIAN EXPOSITION.

New South Wales deserves great credit for the variety and completeness of her exhibits in all departments. In this regard she far surpasses the mother country. The total space occupied in all departments is truly astonishing. We illustrate the New South Wales building, which serves for offices for the commissioners. The building, which was erected in the classical style, measures 60 × 60 feet, and the architects were Messrs. Holabird & Roche, of Chicago. This building is usually called the "Australia House."

The Haiti government building is erected in the Southern colonial style, near the German building. In the tympanum over the front portico is the coat of arms of Haiti. In a kitchen at the rear of the building Haitian coffee is served. The building is of very good size, as it measures 124 × 1[illegible]0 feet. Ample room is provided for offices, exhibition halls, etc.

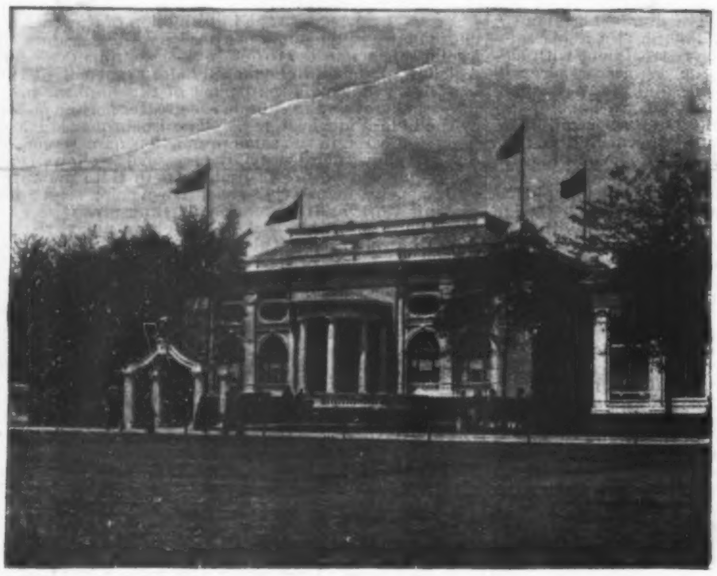
The Utah building is a very modest affair, being only 90 feet long by 50 feet wide. This building was erected at a cost of $18,500; the architects were Dallas & Hedges of Salt Lake City. A large portion of the lower story was devoted to exhibition purposes, the resources of the country being shown by means of specimens, photographs, etc.

The Kentucky State building is a typical example of a Southern colonial house, a plantation house of good size, for the building measures 75 × 95 feet. In front will be noticed a statue of Daniel Boone. The architects of the Kentucky State building were Messrs. Maury & Dodd, of Louisville, Kentucky. In the great fireplace burned great back logs when the chilly blasts of the Windy City began to blow. All of the woodwork is finished in old colonial white enamel. The arrangement of the interior does not differ materially from that of the other State buildings.

The Louisiana State building faces the western annex of the art galleries. The building is simple and affords a good example of a Southern house. Carved wood panels, done by the women of the State, form

NEW SOUTH WALES.

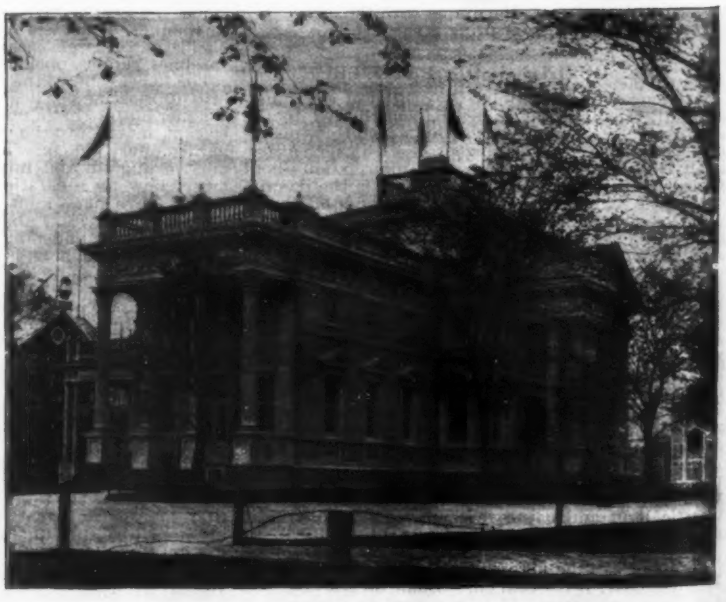
HAITI.



UTAH BUILDING.

KENTUCKY STATE BUILDING.

LOUISIANA STATE BUILDING.



MARYLAND STATE BUILDING.

STATE AND FOREIGN BUILDINGS AT THE WORLD'S COLUMBIAN EXPOSITION.

an interesting feature of the building. One of the rooms is devoted to relics of the French colony in the Bayou Teche country, immortalized by Longfellow. In another room will be found relics of the French and Spanish days. Considerable historical furniture is exhibited in the various rooms. In the creole kitchen all of the glories of the Southern cuisine are served. Here gumbo soup reigns supreme, and all of the delicacies that permit of it are seasoned with that spitefullest of all condiments—tobasco sauce. Those who have eaten a meal here, served in real ante-bellum style, now understand a little of the delights of the South "befo de wah."

The Maryland State building was designed by Messrs. Baldwin & Pennington, of Baltimore, and measures 78 × 142 feet. The free classic style derives its motives from the best Southern colonial buildings of the last century. The building is three stories high. Considerable space is devoted to exhibition purposes. The front entrance leads into a fine reception hall measuring 38 × 40 feet. The remainder of the building is taken up with offices, ladies' parlor, smoking room, etc.

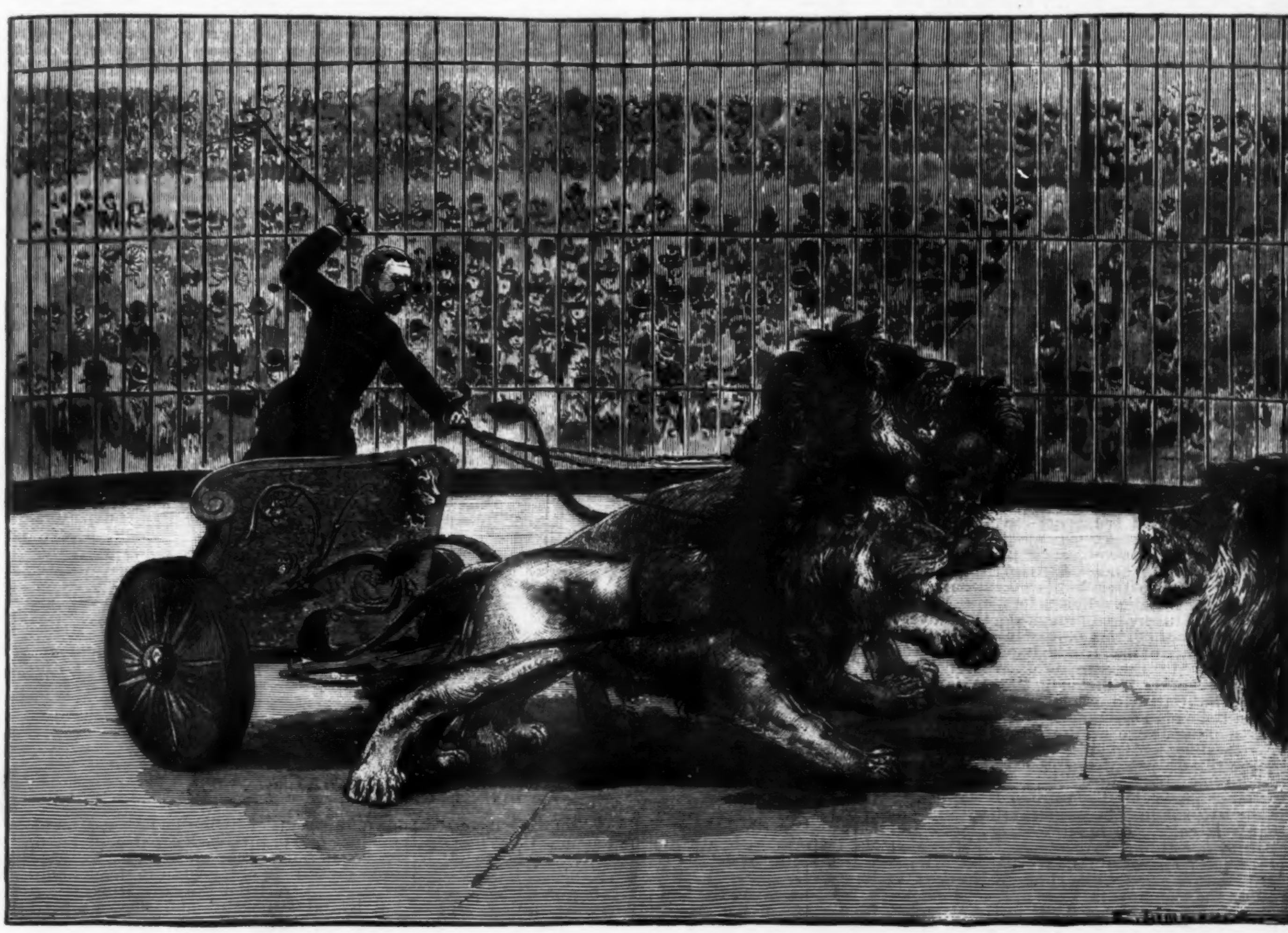
HAGENBECK'S CIRCUS.

ONE of the most interesting and most frequented exhibits in the Midway Plaisance was a European, and what is more, a German show—Hagenbeck's Circus. It was not merely a circus in the ordinary sense of the word, with a clown, ballet dancers, etc., for the greatest menagerie owner and animal tamer in Europe would hardly understand such things. He arranged a menagerie in a large building, and in an arena connected therewith he showed how the wildest beasts can be tamed and trained. In a strong cage over the entrance, about half a dozen lions passed away the time, listening to the serenade given them every day by Hagenbeck's band. One of the queens of the animal world lounged on the parapet, while her spouse looked down haughtily upon the crowd that stared up at him from the terrace in front of his palace, and the young princes looked bloodthirsty and voracious, in spite of their gentlemanly behavior. But when the show began, their sovereignty ceased, for then they had to dance to Hagenbeck's pipe, as the Sultan of Java did to the pipe of the Dutchmen.

In the menagerie the lions share their residence with dogs, bears, apes, and fat pigs, and not even a bristle of the latter was touched; polar bears dwelt with panthers, jaguars with lap dogs and raccoons! A great dog suckled the churlish, rough young of a powerful lion, that licked her nose by way of thanks. But the most remarkable sight was to be found in the arena. In a very large cage in the center of an amphitheater, which was generally filled with spectators, there were lions, royal tigers, panthers, black and polar bears, and other animals all together. A tamer stepped into the cage, whipped the roaring beasts together and drove them before him, making them gather into a close group, and then, oh, horror! he suddenly threw himself on them. His face was so near the teeth of a powerful lion that the spectators feared he would lose his nose, at least; but these lions behaved with their master as did the lions in the Bible with the good Daniel, caressing him and allowing him to scratch their heads behind their ears.

Another number of the programme consisted of building a pyramid of all these bloodthirsty animals and then making the polar bear and tiger climb over them on ladders, and great dogs jump between the spread legs of these animals.

In another number a Roman triumphal chariot was pushed into the arena, some lions sprang forward and allowed themselves to be harnessed to the chariot, and then the tamer climbed in, took the reins of this strange four-in-hand, and drove them around the arena three times. A fearless woman made a lion jump on a white horse, and then they galloped around the arena like cavalry recruits. The interesting programme included many other tricks of the same nature, and the Americans acknowledged frankly that nothing of the kind had ever been seen in the New World before.—*Illustrirte Zeitung.*



THE WORLD'S COLUMBIAN EXPOSITION—HAGENBECK'S CIRCUS.—DRAWN BY E. LIMMER.

THE WORLD'S COLUMBIAN EXPOSITION.

II.—THE LIBERAL ARTS—GERMANY, AUSTRIA, AND JAPAN.

By L. P. GRATACAP.

CERTAINLY the most beautiful of all the buildings at the great Fair is the Agricultural. In many ways it is more fruitful in suggestion, while its slightly uneven surfaces give it a pleasing animation. The strong groups surmounting it, its low dome, with the balanced corner pavilions, the facade of Corinthian columns fronting upon a terrace, pierced by a noble entrance from the water, flanked by the full and plenteous imagery of two symbolic groups, altogether make it most agreeable. Looking at it from the base of the Administration building, when it almost alone fills the view line, the scattered shades and the surfaces of illumination perpetually charm and invite one to a closer scrutiny. It is fortunate, indispensable, indeed, that the high design, whose keynote is given by the glorious Administration building, should be sustained throughout that long space that reaches from the Palace of Mechanical Arts to the Peristyle, by an accordant and artistically adequate building. Fortunate that the resplendent and severe statue of the Republic rising imperiously but beautifully from the water should be supported by so strong and finishedly varied a structure. But contrasted with the Agricultural building, and facing it across the waterway of the basin, stands the enormous mass of the building of Manufactures and Liberal Arts. Here is an interesting solution of an architectural problem, perhaps not altogether met if we regard alone the circumscribed space here alluded to, but met in relation to the broader situation involved in the other aspects of the Fair. The building devoted to Manufactures and Liberal Arts is one of much simplicity in its outline and decoration, but having a capitally designed roof, which rises centrally with a most delightful modulus of curvature, and having also a surrounding court interiorly, which presents on the outside a rectangular space with slanting roof combining with the swelling base of the great central dome. This building, designed by Mr. George B. Post, is of amazing dimensions, and its value as an artistic element resides in its massive effect, the simple sensation of unequaled size, so intellectually treated as to relieve the spectator of a vulgar feeling of astonishment, and give him the more impressive pleasure of admiration and awe. The corners of the building are occupied by towers with entrances and frescoed ceilings, and the center of each side is pierced by a royal columnar porch superbly balanced, noble, and attractive. This building, with its dominant tone of immensity and strength, imparts stability to the whole colony of structures about it, and to the important buildings facing it, as the Agricultural Hall and the Hall of Electricity, as well as to the more remote and elaborate Palace of Mechanical Arts, and seems to serve the purpose of an emotional contrast, while as a supreme *tour de force* it escapes the expression of heaviness, stolidity, and obstructive hugeness. In detail it is overwhelming. It is 1,687 × 787 feet, containing nearly 31 acres on the ground. We are told that "any church in Chicago could be placed in the vestibule of St. Peter's Church at Rome, but this building is three times as large as St. Peter's. The old Roman Coliseum seated 80,000 people, but this building is four times larger than the Coliseum. In the central hall, a single room without a supporting pillar under its roof, 75,000 people could be seated, and each one given six square feet of space. The entire building would thus seat 300,000 persons." Looking upward from the central aisle of this astounding structure, the view of the enormous iron arches is unimpeded. The vastness of the space is hardly realized, yet the height is 213 feet and the span 354 feet. The arches' rise and zenith seem almost circular, but they are moderately oblate, while they act as buttresses to a second series, less inclined and approximately rectilinear, upon which the roof, which has been so much admired, is laid.

The pavilions erected by foreign visitors in this great emporium of industry imperfectly meet the requirements of the place. They seem architecturally out of unison, and fail in altitude, though in the case of France and Germany they are exceedingly elaborate, massive and approximately adequate.

The error made, on the whole, is in the direction of heaviness and lack of buoyancy and ascensional suggestion. Perhaps, though less conspicuous than the rest, the Belgium pavilion more happily, in its frontage, hits the idea of lightness and breadth, yet infinitely beneath the great pavilions of France and Germany in detail and expensive lavishment of ornamentation, and, indeed, otherwise than in its half executed promise, poor and commonplace. The large empyrean in this building dwarfs the booths, departmental pavilions, and exhibits, and seems inadequately filled. The display of flags hung from the roof is insufficient to avert the feeling of emptiness, and there is a sense of regret that broad tapestries, in single sheets of color, forming a chromatic symphony against the hardness of the dull iron, had not been applied. The German pavilion is conceived in a spirit of most generous and painstaking cordiality. In the center upon the main aisle are three metal gateways of wrought iron, forming an impressive entrance into the exhibition spaces behind and about them. Four towers with temple-like basements, marked out by pillars, surround this central space, and the combination is surmounted and presided over in the rear by the symbolic group in bronze of Germania. The whole is expensively conceived, and is animated by the expression of an abundant and copious realization of power and wealth, perhaps a little stilted and cumbrous, but yet excellent in meaning. When we enter the gates—the painstaking

effort of the iron smith who has wrought out leaf and wreath by means of the hammer alone—we meet the superb exhibit of the Berlin Royal Works of Porcelain. In the center is the fine mosaic plaque of Germania, rich in color, academic in treatment, and absolutely perfect in technique. On either side in two raised apartments are the examples of ware which are sumptuous in decoration, but too profuse and inelegant in their Cupids, garlands, twisted figures, and rather vulgar tediousness of expressionless flowers, fruits and beasts. The Meissen (Saxony) Royal Dresden ware is exhibited in an adjoining gallery. The eye is first struck by the great ultramarine vases, beautiful in proportions, and marvelous in solidity of color. Behind and around them in all directions the eye meets the surprising display of plates, candelabra, jewel boxes, pompons, figurines, garlanded mirrors, marvelous in execution, but generally very uninteresting except for their technical perfection. The frills and fichu of a court dandy in this ware is amazingly skillful. Pate sur pate works are here seen, but inferior, at least in mental force, to the great work of Mr. Solon in the English exhibit. The recent work of the Meissen potteries imitates its famous productions of the last century, and its commercial success has been very great. The original sign of the Dresden pottery was the rod of Æsculapius; in 1712 two crossed swords replaced that; these were again modified in 1720 by Horoldt, when gold borders were introduced with violet and iron red, while landscapes, birds, flowers, etc., were profusely used. In 1778 the crossed swords were restored, as the mark, with a circle between the handles, and 1796 Marcolini substituted a star for the circle.

Perhaps more attractive, though superficially less remarkable, is the faience of Mettlach, though here there seems paucity of ideas in design, while the reiteration of Germania and her attendant deities and feeble *genre* subjects fail to heighten the visitor's pleasure. Yet these Dresden pieces in this exhibit are the more pleasing from the absence of strained extravagance in ornamentation. Also in the German exhibit are the superb ivory carvings of Moritz Keller & Co., which are of indescribable intricacy, combined in ingenious unions, as settings or framework of enamel and rock crystal. Besides these very prominent exhibits Germany has contributed examples of her fabrics, her needlework, bronzes, embroideries, carpets and rugs in great profusion. The artistic sense in its recondite and delicate areas of feeling is seldom touched by German work. In all departments they are able, conscientious, exhaustive, but destitute of inspiration. A design of much cleverness is seen in the German exhibit of sixteenth century furniture, in the three bronze mermaids holding a gold net which suspends a glass globe. Among notable technical displays is the extraordinary Bismarck collection of cups, medals, vases and decorations. The labor bestowed upon some of these pieces approaches the marvelous, and the value placed upon them is, we believe, $60,000. The Austrian pavilion is entered from the main aisle just north of the German exhibit. Its design is a royal entrance supported by Atlases, its apex crowned by a bell dome and crown, while on the topmost central pediment stands the double eagle. The whole with its subordinate divisions is heavy and measurably effective.

Easily surpassing all other objects of interest in this section is the Bohemian glass. This glass is exquisitely tinted, and in its patterns of conventional and formal tenuity fascinating. The colors in some instances are of great diversity, of much depth and very beautiful. The flower designs of corollas and calices with blended hues are of real artistic importance. The chased and engraved white ware is of great beauty, and the iron ware of L. Wilhelm, of Vienna, is novel and clever. The Carlsbad glassware, belonging, of course, to the Bohemian styles and workmanship, contains a very striking design in the set of blue vases and cups with silver and gold leaves. The lovely asparagus-green tints, the shades of amethyst, claret and saffron are of inimitable beauty.

The Viennese porcelain (E. Wahliss) is supremely classic and lovely, subdued in ornamentation and unapproachable in color. In luxuriance, opulence and fervor of tints, few things in ceramics could exceed the plaques, "The Four Parts of the World," "The Rape of Europa," etc. The perforated china of Hungary is delightful and the monumental vases unique and bold. The whole of the Hungarian work justly attracted great attention and seemed admirably fresh and tasteful, natural and ingenious. The terra-cottas of F. Goldscheider are attractive, and the frequent admonition of "Don't look with your fingers" was a much-needed remonstrance, for in the matter of knowing all there is to know about fictile ware the sense of touch seems a necessary adjunct to the less subtile sense of sight. The work of the Victoria China Works, of Carlsbad, Austria, is naive in some respects, especially in the thin-necked pitchers, but the ornamentation is somewhat too highly gilded, flaunting and meretricious. The bizarre Bohemian ware of Bodenbach is peculiarly arabesque and pleasing both in design and color, but the horrible magnificence of H. Skiassny, of Vienna, is the outrageous dream of barbaric flatness. The ivory porcelain of Alfred Stellmacher of Teplitz, Bohemia, is amazingly clever. The ordinary Teplitz ware is exhibited in great profusion, and is ornate and delicate. The Haida ware is a trifle dull and affected, is not as successful as that of Bodenbach. The Austrian exhibit is surprisingly interesting, and the prices at which pieces were being sold reasonable.

From Austria we passed still northward to the humble booths of Japan, between the flagstaffs of bamboo, and beneath the stalk crowned eaves of a Japanese temple, and we enter a world of amazing novelty, freshness and grotesque entertainment, sharply contrasting with the products of cultured Europe. Here is a maze of lacquer work, of bronzes, of china vases, idols, embroidered ferns, ivories, screens, rattans and balloons. It is familiar to every one. The Japanese are lacking in a sense for form. They show little appreciation of proportion, and it seems to us as if in their later work they were yielding to mischievous influences in ornamentation, both in color and design. Their art perhaps lacks artistic permanence; it possesses a kind of magical strangeness and antipodal oddity. Much of it, however, fascinates the eye, and we may profitably consider this paragraph of La Farge's where he says, "On analysis, besides the wondrous finish, we notice the novelty of the design, its energy, its accuracy, its sentiment, very often the grandeur of its style, very often a stamp of individuality, personal talent, its recalling of natural objects, the enchanting harmony of its colors, and its exquisite adaptation to the surface ornamented."

The screens in the Japan section remain unique and unadulterated, and are of great softness and infinite labor. Here we saw the great eagle of Saito in bronze, upon which the artist has expended indefatigable labor. We are told that "the lines on the feathers may be counted by hundreds, on some of them by thousands," the work requiring for its completion five years. The technique of their artists is wonderful, and equally their originality in design, which sometimes, however, is more "curious than edifying." After all their blue and white vases are the most pleasing. An exhibit of interest at the Fair is the cases of quartz spheres, among which we noticed an amethyst globe. The "fusiyama" model was frequent.

Generally, in their artistic work, the variety of surfaces, the resources displayed in treatment, the range of color, and multitude of decorative thoughts seem almost incredible. There were silk embroideries here, one, a design of peach blossoms, of the most ravishing beauty, and another of an eagle upon the branch of a pine tree, not so artistic, but laborious. The stamp of industry is evident in all their work, and yet it is not a servile industry, but most endlessly joyful, original and unrestrained. Take for instance the bronze incenser of Watano at the Fair. What an extraordinary fabric! Its mingled mass of gnomes, snakes, elephant tusks, dragons, fish, waves, sea urchins, etc., terminated at the summit of its ten or eleven feet by a spread eagle, seems an impossible creation. One could pass long hours with profit in studying the manifestations in art of this people who have been born among natural surroundings which have animated and refined their artistic powers surprisingly.

UNDERGROUND ELECTRIC RAILWAY, LONDON—THE CITY AND SOUTH LONDON RAILWAY.

THE present seems an opportune time for putting upon record in these pages a condensed account of the City and South London Railway, showing its essential features without entering too much into descriptive minutiæ or details common, it may be, to other lines also.

We propose, in the first place, to give simply a careful abstract of the multitudinous descriptions which were published when the line was opened about two and a half years ago, availing ourselves also of Dr. Edward Hopkinson's paper on the electrical working of the line, read before the Institution of Civil Engineers in February last, and printed in their proceedings, vol. cxii. Doubtless the same or similar methods of construction will be adopted for all other lines which are designed after this principle, inasmuch as complete satisfaction resulted from their use in making the South London Railway. That this is so will very soon be proved when the constructive work is taken in hand for the two extensions of this line already sanctioned by Parliament. These include a continuation at one end of the line from Stockwell (the present terminus) to Clapham Common (a distance of about one mile), and at the other or City end the construction of a new line northward as far as Islington.

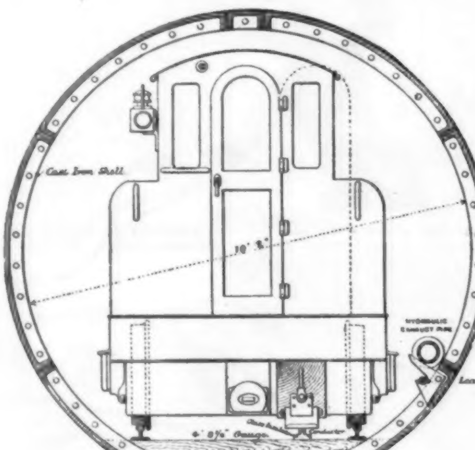
General Features of the Line.—The total distance from King William Street, the City terminus, to Stockwell is about $3\frac{1}{2}$ miles, and there are four intermediate stations, the greatest distance between any two being three-quarters of a mile, while the average distance is about three-fifths of a mile. The entire length is, of course, underground, the rails never being less than 40 ft. below the surface, while in some cases (as, for instance, when passing underneath the River Thames) the depth is considerably greater. The up and down lines are carried in separate tunnels, running generally side by side, but one of them being several feet higher than the other, so as to allow the passengers from one line to pass under the other on their way to the hydraulic lifts by which they are conveyed to and from the street level. At one point, however, near the City terminus, where the line runs underneath Swan Lane, the width of the street between house foundations is only 13 ft.—too small a distance to allow of the tunnels being placed side by side, and they were, therefore, constructed one above the other, so as to avoid all interference with the foundations of adjacent buildings.

On the south side of the Thames the line follows almost a straight course, keeping underneath wide and open streets and roads. These roads lead toward London Bridge, and here a diversion of the line had to be made both laterally and vertically, in order to avoid the bridge foundations, and gain sufficient depth to keep in the London clay. Some very sharp curves were thus necessary—the shortest radius being about $1\frac{1}{2}$ chains. The gradients also are very severe. On the north bank of the river, the up line rises on a grade of 1 in 30, while the down line falls at 1 in 14. There are also short gradients—up and down—on each line at the intermediate stations; these are equal on the average to about one per cent., and serve the excellent purpose, on the one hand, of helping the brakes to stop the train, and, on the other hand, give an impetus at starting, and thereby relieve to some extent the heavy initial strain upon the locomotives. It is, of course, hardly necessary to remind our readers that this line is worked wholly by means of electric power; and some details of the method employed will follow in due course.

Permanent Way and Works.—The tunnels are formed of cast iron throughout, excepting at the stations, which are of brick, on the usual arch and invert construction, with a diameter of about 20 ft. The line tunnels or tubes are 10 ft. in diameter over part of the line, and 10 ft. 6 in. for the remainder; they are formed of rings 20 in. wide, consisting of seven segments—six of these are equal in size, while the seventh is a small piece with parallel sides, acting as a key at the top of the tube. All the segments are flanged, $3\frac{1}{4}$ in. deep and $1\frac{1}{4}$ in. thick; and $\frac{3}{4}$ in. bolts serve when screwed up to bind the flanges securely together. The circular joints between each adjacent ring are all calked with tarred rope, and the horizontal joints between segments with strips of pine. In wet soil, cement was also employed to make sure of the joint. A total weight of 30,000 tons was used in the structure, and bolts to the number of 1,500,000.

Owing to the depth below ground level at which the line runs, it was obviously essential to employ some reliable and rapid method of conveying passengers up and down, apart from the use of stairways, and accordingly at each station there was constructed a lift well, 25 ft. diameter, lined with cast-iron rings in a similar way to the tunnels. In these there run up and down, by means of hydraulic power, a couple of semicircular cages or lifts, each capable of holding 50 passengers, or half a complete train load. The necessary water pressure is obtained from steam pumps and an accumulator erected in the generating station at Stockwell, hydraulic pressure and exhaust pipes being run throughout the length of the tunnels on side brackets bolted to the cast-iron segments. The water is supplied at a pressure of 1,200 lb. through a 7 in. main, the latter being gradually reduced to $3\frac{1}{4}$ in. diameter as the distance increases. Lift cylinders $6\frac{1}{2}$ in. diameter are employed in a very similar fashion to the Otis elevator. The cylinder is fixed vertically to the side of the well, and is given a treble purchase by means of sheaves and wire ropes. Four of these ropes—each with a breaking strain of 55 tons or 220 tons in all—are attached to each cage; there are also two wire ropes connecting the counterweights with the cage, and since the latter only carries a load of $3\frac{1}{4}$ tons, there is no fear of breakdowns. Even in case of such an event, safety-braking gear comes into play, and only a few weeks ago proved its efficiency in this direction. The ascent with full load is made in about thirty seconds. After passing through the lift cylinders, the waste water is all pumped back to the generating station, thus being used over and over again. Details of the pumping engines and accumulator will follow when we deal with the station. A second accumulator $9\frac{1}{2}$ in. diameter, with a stroke of 27 ft., is placed near the middle of the line to reduce the velocity of flow through the pipes.

The gauge of this line is of standard size—4 ft. $8\frac{1}{2}$ in.; steel T rails are employed, weighing 60 lb. to the yard. The track is not ballasted, the wooden cross sleepers merely resting on the sides of the iron tunnel. The electric conductor, from which each train takes the current sent out from the generating station, is also mounted on the sleepers, between but not central of the line rails, glass insulators fixed to alternate sleepers being employed to support it. This conductor is formed of channel steel, weighing 10 lb. per yard, and rolled from mild steel of special composition. Its specific resistance is very low, corresponding to 0·05 ohm per 1,000 ft. The level of the conductor is about



SECTION OF TUNNEL BETWEEN "CITY" AND "ELEPHANT AND CASTLE" STATIONS, CITY AND SOUTH LONDON RAILWAY.

Items.	Half Year Ending				
	June 30, 1891.	December 31, 1891.	June 30, 1892.	December 31, 1892.	June 30, 1893.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Salaries, offices, expenses, and superintendence	65 12 0	100 8 4	192 3 4	148 11 8	122 10 0
Running Expenses.					
Wages connected with working the generating and locomotive engines	3,408 16 10	3,258 1 9	2,720 8 1	2,788 12 6	2,687 12 7
Fuel	2,054 4 10	1,985 18 6	1,970 19 4	2,172 0 9	1,845 18 9
Water and gas	251 5 6	263 9 6	253 11 0	252 9 9	242 12 6
Oil and stores	434 2 1	371 18 1	415 3 4	457 6 11	426 19 2
Repairs and Renewals.					
Wages	150 0 0	26 3 9	205 0 0	240 0 0	252 4 0
Materials	223 2 1	193 13 0	277 17 10	289 3 1	298 4 10
Total	6,587 3 4	6.199 12 11	6,035 2 11	6,348 4 8	5,876 1 10
Total of running expenses only	6,148 9 3	5,879 7 10	5,360 1 9	5,670 9 11	5.203 3 0
Train mileage	174,435	188.666	188,944	214,417	247,664
Total cost of locomotive and generating power per train mile	9·1d.	7·8d.	7·7d.	7·1d.	6·48d.
Cost of running expenses per train mile	8·4d.	7·0d.	6·7d.	6·3d.	5·7d.

one inch below that of the line rails. This necessitates an arrangement for lifting the traveling conductors (fixed to the train locomotives) over the crossing rail at points or junctions. On either side of the crossing rail a gap is made in the conductor, which is replaced by inclined planes of wood, up which the collectors slide to a level above the crossing rails, the latter passing through a space left between the wooden planes. The collectors cross the space at an angle, and are wide enough to bridge it. As each locomotive is provided with three collectors, the continuity of the electric circuit is not broken at any time, since the leading collector makes contact with the steel conductor in advance of the break before the trailing collector leaves the conductor behind the break.

The conductor is divided into sections, and arranged so that any section can be coupled through automatic cut-outs to the adjacent sections, or independently to the feeders or electric supply cables. Thus any section can be isolated for the purpose of testing or repairs, and is automatically disconnected in case of any accident causing a short circuit to earth. The return circuit is made through the rails, which are practically uninsulated. The actual leakage on the entire system is, owing to the conditions prevalent, very small indeed, not generally exceeding one ampere, or say two-thirds of a horse power at the working voltage. It is, in point of fact, usually much less than this.

Incidentally it may be stated that the iron tunnels do not in themselves form a complete metallic circuit, as they are broken at the stations by large arches of brickwork, but at these points the electrical connection is made continuous by means of copper cables. The line rails are connected in the usual fashion—mechanically—by means of fish plates; but copper strips are also fixed at each joint to give a complete electric circuit. Adjacent lengths of steel channel conductor are jointed with two small fish plates, fastened by four bolts; copper strips—laminated and secured by copper rivets—are also used here to insure sound electrical contact.

Plain brackets, riveted to the vertical flanges of the bottom cast iron tunnel plates, serve to support the hydraulic pressure and exhaust pipes and also carry the electric cables or feeders supplying current to the steel channel conductor at suitable points. These feeding mains or cables—four in number—are of the well-known Fowler-Waring make, and consist each of 61 copper wires, 14 B. W. G., highly insulated and covered over all with a lead sheath. They are led into the signal boxes, wherever these occur, and are there connected to small slate distributing boards, fitted with plugs and fuses. Short lengths of cables connect these boards with the steel channel conductor, so that, practically, the feeders are divided into sections at each signal box, protected, as already mentioned, by fuses under constant supervision. Two of the feeders are carried in this way from the generating station as far as Great Dover Street, Borough, a distance of 4,000 yards. The other two are coupled in parallel as far as Stockwell, and one is continued to the Oval, where its final connection to the working conductor is made at a distance of some 1,400 yards from the generating station. All the feeders have an insulation resistance of not less than 500 megohms per mile. At each station is a signal cabin provided with a complete set of block instruments. Some of the levers are electrically locked with the signals, and one of them can only be released ordinarily when the locomotive has passed over a treadle beyond the signal.

Generating Station.—The generating station is situated near the high road from London to Clapham, about 500 ft. from the Stockwell terminus of the line. The steam equipment consists of eight Lancashire boilers, each 28 ft. long and 7 ft. diameter, fitted with Vicars' mechanical stoking appliances. The boiler floor is 12 ft. 6 in. below the ground level, and the boiler house is roofed over above the stoke hole, the fuel being shoveled directly into the hoppers of the mechanical stokers. The boilers are set on Livet's principle, arranged in two groups of four, with independent flues and chimneys. A Worthington pump is employed to feed the boilers, the water being forced by it through two feed-water heaters. The exhaust steam from the engines passes through the feed-water heaters to the chimney.

The boiler pressure is 140 lb. per square inch. In addition to providing steam for the main dynamo engines, the boilers also supply the hydraulic compressing engines, compressed air pumps, and other prime movers in and about the station. The steam pipes from the two groups of boilers are so arranged that either or both of the groups can be connected to the main pipes supplying the engines, which are also duplicated. The engines are non-condensing, as condensing water is not available at present.

In view of early extensions to the line, and to afford the ample reserve of power deemed necessary by the Board of Trade, four main engines and dynamos have been installed, although two are quite sufficient to work the line. The engines are of the vertical, compound open type: the cylinders—17 and 27 in. diameter—are placed side by side, having a stroke of 27 in. Both cylinders are steam jacketed with high pressure steam: the normal revolutions are about 100 per minute, giving a piston speed of 450 ft. per minute. They are each fitted with automatic expansion gear on both cylinders, controlled by a high speed governor driven by ropes from a pulley on the crank shaft. The flywheels are very massive, being 14 ft. diameter, 28 in. wide on face and weighing 14 tons. They are carried between the cranks, which are of disk form.

These engines will each indicate about 400 horse power. They drive the dynamo pulleys—34 in. diameter—by means of link leather belts running over jockey pulleys in order to economize the space occupied by the generating plant without diminishing the area of belt in contact with the flywheels and pulleys. The generator dynamos are of the Edison-Hopkinson type, constructed by Messrs. Mather & Platt, with drum armatures 19¾ in. diameter. The field magnet cores are wound with both shunt and series coils, thus forming a compound machine; but the series coils can, if desired, be cut out either wholly or partially by means of switches fixed to each machine, which is thus turned into a simple shunt dynamo. Each machine is capable of giving an output of 450 amperes at 500 volts, at a speed of 500 revolutions per minute. The electrical efficiency at full load is 96 per cent.; the resistance of armature, 0·017 ohm; of shunt coils, 96 ohms, and of series coils, 0·015 ohm. Each armature weighs 37 cwt., and a complete machine about 17 tons. The frictional losses amount to 2·7 per cent. of full load, so that the commercial efficiency is 93·4 per cent.

From the dynamos the current is led directly to a switchboard of simple form, so arranged that any of the four generators can be coupled to any of the four feeders, either independently or in parallel; and these combinations can be altered while working without interrupting the current. The electromotive force of each dynamo is measured by a Kelvin electrostatic multi-cellular voltmeter, and the current through the feeders by means of an ammeter. A special low-reading form of the latter instrument is employed to measure the leakage on any part of the conductor system exposed to the full potential. The feeders are provided at the switchboard with fusible cut-outs and quick-acting safety switches which automatically throw a resistance into circuit if the current exceeds a certain amount; the object being to prevent injury from a possible short circuit at any point in the conductor system.

The remaining apparatus and appliances at the generating station include a set of three compound steam pumps for working the hydraulic lifts throughout the line; also three Westinghouse air compressors, used to charge the air reservoir at the station from which the train brake reservoirs draw their supply after each journey; a very powerful double geared hauling engine operating a drum, on which is coiled a wire rope, used for hauling the carriages or trains up the steep incline of 1 in 3¼ between the tunnels and the ground level at the station; and lastly, a small inverted vertical or wall steam engine employed in operating the machinery and tools in a repair shop attached to the station.

The hydraulic engines are each equal to 170 indicated horse power, having steam cylinders of 15½ in. and 29¾ in. diameter respectively. The stroke is 20 in., and the pump cylinders are 3·9 in. diameter, the plungers being half the area of the cylinders. The water under pressure is stored in a large accumulator 17 in. diameter, with a stroke of 17 ft.

The Westinghouse brake pumps are of the usual type—such as are seen on the locomotives of any steam railroad where this automatic system is employed—and therefore hardly require any further description. The hauling engine is, however, of a very powerful type. It is mounted under the ground level, in a pit beneath the carriage shed floor, and consists of a single steam cylinder, from which is driven a crank and heavy flywheel. On an extension of the crank axle is a pinion gearing, with ordinary straight teeth, into a large double-shrouded spur wheel, mounted upon a short length of countershaft. The latter also carries a second pinion of similar design, gearing into a second spur wheel upon the drum shaft.

In the repair shop are a few machine tools—lathes, drills, etc., such as are required for the occasional mishaps or wear and tear of locomotives unavoidable in railway work; also an arrangement for testing new or repaired armatures when mounted on the axles ready for work.

Rolling Stock.—This line, as already stated, is worked entirely by means of electric locomotives, that is, the electric motors which serve to propel the trains are mounted upon distinct vehicles carrying no passengers themselves, but drawing usually three passenger cars to each train. In this respect, therefore, it resembles an ordinary steam railroad, and is unlike the Liverpool Overhead Railway, where the electric motors are mounted upon the passenger car trucks themselves, no locomotives being employed. The essential and distinguishing feature of the South London locomotives is that the armatures of the electric motors are mounted directly upon the axles, the field magnets being supported at one end by bearings on the axle and at the other by links which connect the magnet yokes to cross beams of the locomotive frame. There is thus some amount of angular play permissible in order to compensate for a rise and fall of the axle boxes in the horn blocks. The weight of one axle with its wheels, axle boxes, and springs, and with the armature attached, is 24 cwt. Of the total weight of the magnet system, about 10 cwt. rests upon the axle, so that the dead weight on each axle is 34 cwt. The total weight of each entire locomotive is 10 tons, 7 cwt. Assuming a weight of 40 tons for each train loaded, this gives a ratio of adhesion weight to total load of about one-fourth. This compares very favorably with ordinary practice, a ratio of one-fifth being usual upon steam roads: but any trouble from this point need hardly have been feared on the South London line, owing to its independence of atmospheric conditions. The use of direct acting motors, which were introduced by Messrs. Mather & Platt for the first time on the South London line, has been watched with great interest. Their success is undoubted, and they will no doubt be adopted in the other metropolitan railway schemes, as they have been on the Liverpool Overhead line.

The two motors on each locomotive are capable together of exerting 100 horse power, at a speed of 25 miles per hour, corresponding to 310 revolutions of the axle per minute. The magnets are of the Edison-Hopkinson type, series wound, and the armatures are wound Gramme ring fashion. The resistance of the magnet coils in each motor is 0·087 ohm; and that of the armature 0·3 ohm. The two motors are connected in series: the current is taken from the steel channel conductor by means of three sliding shoes fixed by hinged supports to the frame. These shoes are of cast iron, and it is found in practice that they will run 10,000 miles before wearing out. From the shoes the current passes through a fusible cut-out and main switch to a resistance switch for throwing in resistance at starting. Thence it passes through a reversing switch to the motors, and finally through the axle boxes and wheels to the rails of the permanent way.

The motor magnets are so wound as to be nearly saturated with the mean working current; beyond this point the tractive force increases almost uniformly with the current, being 1,180 lb. at 100 amperes, and 3,000—the maximum—at 226 amperes.

Each locomotive is provided with two air reservoirs placed under the curved side plates of the cab, with a total capacity of some 16½ cubic feet. These carry a supply of air compressed to a pressure of 80 lb. to the square inch, for working the Westinghouse continuous automatic brakes fitted throughout the trains: they are recharged, after each round trip, from a reservoir at the Stockwell terminus, which is kept at constant pressure by the small steam pumps already noticed in connection with the generating station. The locomotive reservoirs are sufficient for 30 stops from full speed. Powerful hand screw brakes on the locomotives are also provided as a stand-by. The leading dimensions of these electric engines are as follows: Length over all, 14 ft.; length of cab, 10 ft.; width of cab, 6 ft. 3 in.; wheel base, 6 ft.; diameter of wheels, 27 in.; height over all from rail level, 8 ft. 5¼ in.

The locomotives owned by the South London line are 16 in number, 12 of these serving to run the entire stock of 36 carriages. The trains are each made up of a locomotive and three carriages, connection being effected by means of a central buffer and coupling combined. A recent description of the carriages, forming, perhaps, the most complete yet published, gives the following details:

"The South London Railway carriages are each carried on two four wheeled bogie trucks, and are so connected together that a movable platform carried by the bogie frame swings between each pair of carriages, being independent, therefore, of the carriage frames or bodies. These platforms are covered with a sheet iron canopy overhead, carried on four pillars of steel rod, and are fitted at the sides with Bostwick collapsible gates.

"Down the center of each carriage runs a passage, and doors are fitted at each end, made to slide in two halves, so that although the carriages make what is practically a vestibule train, yet each one may be—and is, when running—separated from the others by closing the doors. Passengers are not allowed to stand upon the end platforms while the train is in motion, a guard, or conductor, being put in charge of each platform to open and close the end and side doors as required.

"The carriages are each divided in the center by a transverse partition, with an open archway the full width of the central passage, but without doors of any kind. This arrangement gives the impression of a double carriage, or two compartments. The seats are placed, as in the usual type of tramcar, longitudinally on each side, and are upholstered both on the seats and backs. Above the back of the seats there are fitted into the side of the carriages ornamental glass panels and mirrors. Four incandescent lamps, sup-

plied with current from the main circuit, serve to light the interior of each carriage, oil lamps being also provided in case of emergency, and for use when the current from the line conductor is momentarily cut off.

"The line voltage varies, of course, very considerably, and consequently the incandescent lamps are somewhat unsteady, and some arrangement might with advantage be made for the employment of storage batteries of small size and light weight for illuminating the carriage interiors.

"The carriages are each 26 ft. long over the body framing, 29 ft. long over all, and the width is 6 ft. 10 in. The height from rail level to crown of roof is 8 ft. 4½ in. The whole of the framework of the bogies is of steel, and so also is the main frame of the body. The side portion of the main underframe is made of a girder, in a shape somewhat like the following,

in order to allow of the bogies swinging round on a curve.

"In the construction of the body the principal kinds of timber employed have been Moulmein teak for both scantlings and panels; yellow pine for the roof, floor and inside casing. Hair felt is inserted under the floor boards and in the sides of the carriage to deaden the noise. The bogie wheels are 2 ft. diameter, and have Bessemer steel tires and axles; the centers, or hubs, are of wrought iron, Moulmein teak sections being built up to form the wheel body and rim, after the well-known plan adopted by Mansel. Retaining rings of the Mansel type are also used for securing the tires to the rims. The axle boxes are fitted with oil lubricators, and provided with patent dust shields."

The average speed of working on the South London line, including intermediate stoppages, is 11·5 miles per hour, and of actual running between stations 13·5 miles per hour. The maximum speed attained between stations varies from 20 to 25 miles per hour. The service varies from 3 to 4 minutes, 16 or 17 trains leaving each terminal station in one hour. This compares very favorably with the service on the Liverpool Overhead Railway, where trains are running every five minutes at a maximum speed between stations of about 30 miles per hour.

The table on preceding page, based upon the half yearly returns of the company, shows the total cost of locomotive power and the train mileage, from which the cost per train mile is deduced. It will be seen that for the half year ending December 31, 1892, it is 7·1d. per mile, and the cost of running expenses only 6·3d. per mile; while for last half year—January to June, 1893—the cost has been still further reduced.

In the paper read by Dr. E. Hopkinson before the Institution of Civil Engineers, a careful analysis is given of the cost of working for the half year ending December 31, 1892, which we now reproduce. It will be seen that the cost of production of the electrical power is less upon the City and South London Railway than in the generating stations of the various lighting companies.

CITY AND SOUTH LONDON RAILWAY.

Half year ending December 31, 1892:

Train mileage	214,417
Number of passengers	3,317,602

Cost of working generator station, excluding office expenses:

	£	d.	
Wages	1,012	1·12	per train mile.
Fuel	2,172	2·42	"
Water and gas	252	0·28	"
Oil and stores	368	0·41	"
Repairs and renewals	321	0·36	"
	4,125	4·59	

Equivalent to 1·56d. per Board of Trade unit.

Cost of locomotive working, excluding office expenses:

	£	d.	
Wages	1,776	1·98	per train mile.
Oil and stores	89	0·10	"
Repairs and renewals	208	0·23	"
	2,073	2·31	

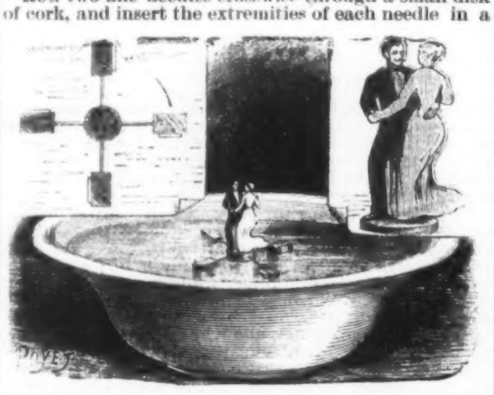
The line was opened for public traffic on December 18, 1890. Since that time the locomotives have run more than 1,100,000 miles, and have provided for a traffic of over 15,000,000 passengers, and the yearly mileage of each locomotive in regular running exceeds 30,000 miles.—*Railway World.*

A COLOR TINT PHOTOMETER.

MR. ALFRED M. MAYER has described in the *American Journal of Science* a photometer which he has devised for measuring the intensities of lights of different colors. The instrument is constructed in such a manner that the two tints to be observed are reduced to the same by the effects of contrast. Two disks of thin Bristol board, 18 centimeters in diameter, have half of their surface removed in the shape of eight equidistant sectors. Between them is placed a circle of white tracing paper, and the disks are then clamped together with their spaces coincident. The compound disk is mounted on a rotator and placed opposite two silvered mirrors inclined at an angle of 150°. The plane of the disk bisects the angle formed by the mirrors, so that an observer standing in front of the arrangement can see both sides of it at the same time. If now the disk is rotated while illuminated by daylight on the one side and by lamplight on the other, the side illuminated by daylight appears white tinted with yellow, and the other side appears white tinted with blue. A compound disk of red lead, of chrome yellow, and of white cardboard was placed by Mr. Mayer on the daylight side, and an ultramarine, emerald green, and white disk on the lamplight side. The greenish blue produced by the latter combination made the light blue on the lamplight side appear faintly orange yellow by contrast; while on the other side of the ring, the orange yellow disk had diminished the orange yellow tint of the ring to the same feeble orange yellow as seen on the other side. Mr. Mayer calls this a study of the phenomena of simultaneous contrast color; but how the arrangement acts as a photometer does not appear at all clearly from his description of the effects.

THE TIRELESS WALTZERS.

RUN two fine needles crosswise through a small disk of cork, and insert the extremities of each needle in a



small flat rectangular piece of cork, and to the surface of each of these pieces, and always on the same side, affix a small slice of camphor. The plan in the upper left-hand corner of the figure gives the exact dimensions of the apparatus thus constructed. If the apparatus be placed upon water, it will begin to revolve rapidly of itself and continue to do so for several days.

Here we have a wonderful result obtained by very simple means, but, in order to be certain of success, neither the apparatus nor the water must come in contact with the least particle of a greasy substance.

Therefore, when it is desired to construct one of these apparatus, the hands must be thoroughly washed, and, were there any suspicion that the fingers were greasy, it would be necessary to wash the apparatus with ether, in holding it with a pair of pincers, and then place it upon the surface of water contained in a perfectly clean plate.

The camphor is affixed by means of sealing wax. A little melted wax is dropped upon the cork, and after being resoftened in the flame of a candle, the piece of camphor is immediately applied by means of a pair of pincers.

This curious experiment may be rendered more pleasing by fastening vertically to a needle inserted in the center of the cork disk a couple of waltzers cut out of thin paper. If the apparatus is constructed with the precautions just indicated, the tireless waltzers will be seen to revolve for three days.—*L'Illustration.*

FISHING ON THE COAST OF TONKIN.

FISHING is a source of great wealth to a country, whether it is a question of fresh or salt water fishery. Thus, in France, the product is figured by millions. Since it can be carried on in new countries without any preliminary expense of setting to work, it will be understood that it possesses a very particular importance in the most recently acquired colonies. We have thought that it would prove useful to show that the coast of Tonkin is very well favored from this point of view.

Fish are always abundant off the coast of Tonkin and the provinces of Vinh and Thanh-Hoa, always remaining in the gulf, but forming in shoals, which change their situation at periodical epochs. There are numerous species of them, bearing but little resemblance to the fishes that we habitually consume in Europe. First, we have the *vang-tiack*, a sort of white bonito, in very great demand, weighing as many as twenty-five kilogrammes, and selling, sorted, at eight piasters (four francs) per picul (sixty kilogrammes); then the *tai-tei*, a species of red or silvery dorado, of low price and of a mean weight of from eight to ten kilogrammes; and the *xi-pha-gui* and *ougui*, species of gray or spotted garnet, weighing from five to six kilogrammes on an average, and selling for five piasters per picul.

Fishing is also done for the *ta-hou-lou*, or sea carp, huge soles known by the name of *loug-ly*, and a species of tazard, called *moung sin*. All these fish of little value are employed in the manufacture of *nam*, or brine mixed with pounded fish. Fishing is likewise done for the *mahi* (sepia) and *fao-hi*, which are prepared in a very peculiar manner and sold at a very high price.

The fishing may be divided into littoral and movable fishing a little more toward the open sea. This latter is done exclusively by the Chinese inhabiting China. The principal apparatus that they employ are the dredge, the doubled net, the drag net, and bottom lines. The fishing begins toward September and October, at the time when the severe heat comes on. Then arrive the junks from China, notably from Pack-Hoi, in flotillas of from fifty to sixty, and touch at the port of Cac-Ba, where it is necessary, in the first place, to get things to rights with the custom house, by depositing arms and ammunition, paying some very moderate navigation duties, and getting numbered. The crews, consisting of six or eight persons (some of which are women, and often children) to each junk, put their apparatus in order, render Buddha propitious by offerings in the maritime pagoda, and proceed two by two to the fishing places.

When the weather and depths permit of it, two junks cast a large net that sometimes reaches a length of five hundred meters and which carries in the center a large pocket having stronger and closer meshes than those of the rest of the net. Then the junks set sail parallel with each other and drag the net, after the manner of a seine, for a distance of several miles. From time to time a man sets out in a rowboat toward the center of the net and dives in order to judge whether the pocket contains a good catch. In case it does, the junks approach each other in hauling up the net by the extremities. When the pocket reaches the level of the water, the fishes that it contains (which may often be estimated at several thousand kilogrammes) are scooped out with baskets. If this mode of procedure is impossible, each boat is content to drag behind it a fifty meter net or a dredge in order to take the soles and rays at the bottom. The entire product of the fishing is transferred to large, swift junks, which carry it immediately to Pack-Hoi in a little brine. There it is prepared for shipment to the interior. In 1891 there were exported in this way 2,829,000 kilogrammes of fish and 639,000 kilogrammes of shrimps.

We have said that there is also a littoral fishery. It is the inhabitants of the coast who exploit this for a large variety of fish that seek the mixed water; but the apparatus that they possess is but rudimentary. They establish fisheries in all the mouths of rivers with large poles, forming a barrier and supporting a pocket net that they haul up every day. Upon the littoral banks that are exposed at low tide they plant thousands of perpendicular hedges analogous to the crawls of certain of our French coasts, and forming a triangle that terminates at its apex in a network pocket, which the fish enter at the lowering of the tide. Finally, a large number of the natives employ the most varied apparatus, torches, gigs, square nets, lines, etc., for fishing on foot or in boat. It is estimated that thirty million kilogrammes of fish are annually taken near the coast. Figs. 1 and 2, drawn from nature, represent the fishing with the square net. On the coast of Tonkin, this apparatus is installed on board of a sampang, but in the rivers of Annam, where there is no agitation, a raft is used. In both cases the installation of the levers is very apparent in the engravings, and it is unnecessary to explain it.

For shrimp fishing, the Annamites employ large, flat sampangs painted white beneath. At night, the shrimps, thinking that day is breaking, leap around the obstacle, and some of them fall into the boat. The others are taken around about by means of the nets stretched upon bamboos, shown in one of our engravings. We may add that our friend, Mr. Roulet, has seen Annamites fishing with small nets of bamboo fiber in front of the bar of Quin-Hone. Two men jumped into the water, each holding a net, and disappeared beneath the surface, and returned to land with a good catch. This operation was repeated by them ten or twelve times a day.

Let us say, further, that lobsters are found at Cac-Ba, and that the rocks of the archipelago are covered with small and excellent oysters at certain epochs. The latter, however, are not much appreciated by the

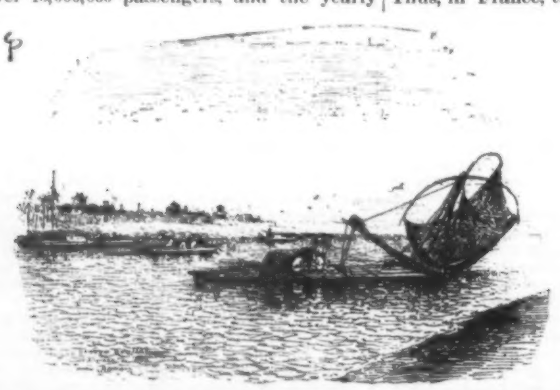


FIG. 1.—FISHING WITH THE SQUARE NET IN THE RIVER HUE.

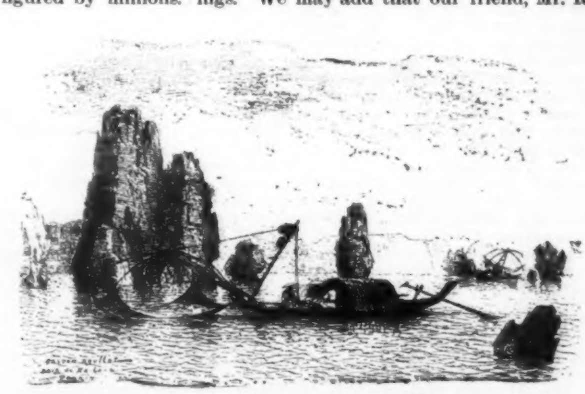


FIG. 2.—FISHING WITH THE SQUARE NET ABOARD A SAMPANG IN THE BAY OF HALONG.

natives. In the Bay of Nan-Hai even, tradition has it that in the last century the Chinese fished for pearl oysters, and, very recently, traces of these exploitations and a few pearl oysters have been found at the Timatiao and Koanlau Islands. Although there are no regulations as to the fishing, the fish appear in nowise to diminish, as the most accurate data demonstrate.—*La Nature.*

THE COLOSSEUM.

THE Flavian Amphitheater, or Colosseum, one of the most stupendous ruins of Imperial Rome, was finished in 80 A. D. The location of the colosseum is superb, being situated at the end of the Forum and at the intersection of several roads. The structure itself occupies a part of the site of the golden house of Nero. The colosseum is so inseparably connected with tales of martyrdom and gladiatorial combats that a tissue of romance has been woven around the old arches until it has been invested with an interest for the traveler which probably no other monument of antiquity can boast, save, perhaps, the pyramids of Egypt. We present a view of the interior during one of the lectures which are given tri-weekly by archæologists, the cards of membership in the party being sold for one franc. Our engraving is from the London *Illustrated News.*

Some idea of the size of the colosseum may be obtained when it is stated that 87,000 spectators could be accommodated at once. On the day of its opening 5,000 wild beasts were slaughtered. The stories of martyrdom do not bear the searchlight of modern historical criticism. The number of the martyrs who came to their death in the huge arena is becoming beautifully less, and now the authentic cases do not number as many deaths as occur in an ordinary New York-Chicago railroad accident. The colosseum is built of travertine tufa and brick, with the plentiful use of concrete. The exterior was divided into four stories and the interior into three. Our illustration shows the arches supporting the seats. The seats were all numbered, and tickets of admission were issued which designated not only the number of the seat, but the section and the staircase to be used. The arrangement of the seats was so nearly perfect that a crowd of 60,000 persons was handled without confusion. Special seats were, of course, reserved for all dignitaries. The new excavations have brought to light many interesting facts. The removal of the flora of the colosseum, in 1871, was carried out in the belief that the life of the structure would thereby be prolonged, but it was injured more in the removal of the luxuriant verdure than it would have been by the flora for centuries. This noblest of ruins seems always destined to suffer more from the hand of man than from that of nature. The subterranean corridors and passages are now exposed in an admirable manner for study. Under the arched podium or raised platform on which the emperor, senators, and vestals sat are a number of arched cells made in the thickness of the wall. These were undoubtedly intended for wild beasts. This belief is confirmed by the discovery of a channel of running water for them to drink, and behind each cage was a trap for the descent of the keeper. In the center a semicarbonized platform of wood has been discovered. This is supposed to have been part of the tramway used for conveying cages of wild beasts and scenery into the arena. The cages were then lifted up first by means of inclined planes, and these were in later times succeeded by the use of the windlass, the bronze sockets and the stone abraded by the ropes having been found.

Ten feet below the modern level of the amphitheater were found massive travertine corbels in pairs, with a channel in the brickwork between each. These corbels were evidently intended to sustain the masts which supported the huge awnings used to protect the people from sun and rain.

A long passage, or *crypto-porticus*, has been cleared out to a distance of 250 ft. or more, and interesting *graffita*, or caricatures and jokes, have been found scratched on the wall. It is thought by some archæologists that the wild beasts were introduced into the arena from the Cælian hill by this passageway. Much delay was caused in excavating the arena because of tapping an old drain, and the level of the water could not be reduced, even by a steam pump, until a connection was made with another antique drain at a lower level. Traces have also been found of a continuous wooden gallery at the top for the sailors who attended to the furling of the huge awning which protected the spectators.

ARCHÆOLOGISTS IN ROME—A LECTURE IN THE COLOSSEUM.

ICEBERGS IN THE SOUTHERN OCEAN.

By WILLIAM ALLINGHAM.

SINCE November, 1891, reports of ice in the lone southern ocean have been frequent, and the end is not yet. It seems very probable that 1892 will prove to be the record year for icebergs in the South Atlantic, as regards quantity, massiveness, and equatorial drift. The Dunsyre sighted icebergs on November 14, 1891, in 43° S. 17° E., and sixteen days later apparently the same dangers were observed from the Gainsborough in 45° S. 9° E. On December 8, in 44° S. 14° E., the Winifred was surrounded by bergs about 400 ft. high, one of which broke up, but not sufficiently near to injure her. The Semiramis and the Magnat both passed bergs in 44° S. 10° E. on the 12th, the City of York on the 14th, while running along the 48th parallel of south latitude, between the 103d and 108th meridians of east longitude, the steamship Coptic in the same longitude, but two degrees farther south, and ships arriving at Australian ports from England reported having fallen in with icebergs off the Cape of Good Hope throughout December.

An enormous amount of heat is required for the simple liquefaction of ice, so that probably the same icy masses may be seen in different positions during several successive months. So far as we can ascertain, the next report of icebergs in southern waters was received from the steamship Fifeshire, Captain Cuthbert, homeward bound from the Antipodes. Many bergs were passed by her between 57° S. 147° W. and 59° S. 109° W., from February 4 to 9, 1892.

Nothing more was heard of these unwelcome wanderers for some time, but on April 6, in 46° S. 36 W., the Cromdale, Captain E. H. Andrew, narrowly escaped destruction. She stood boldly on into a wide opening between two icy cliffs having an altitude of 300 ft., on the assumption that the open sea lay beyond. This apparent passage, however, proved to be a horseshoe-shaped bay formed in an immense ice island, and she had to beat out again. One berg in the vicinity was not less than 1,000 ft. high! Captain Andrew is a young and careful observer, not at all likely to allow imagination and awe more than their due weight, and he personally assured us that his eye measurement was reliable.

Many bergs were passed by the bark Valdivia, Captain Lewis, on April 21, in 50° S. 50° W., during foggy weather, and a very large one was close alongside in the early morning of the 24th in 43° S. 35° W. She was going eight knots at the time, and, owing to intense darkness, it was impossible to make out the danger when distant more than a ship's length. Eighty-five bergs hove in sight during the next eight hours, and the last ice was passed in 39° S. 31° W. on the 27th.

The Duntrune, while running ten knots an hour on the 23d, collided with a berg, almost end on, in 47° S. 38° W. She received serious damage to her bows, and was partially dismasted. Sterling seamanship pulled her through; and, although hundreds of bergs were in the vicinity, and great difficulty experienced in clearing them, she eventually reached her destination without further mishap. One month later the Strathdon, Captain A. T. Wills, was surrounded by bergs in 45° S. 25° W. One of these stupendous stragglers from the Antarctic ice barrier, only barely avoided by careful seamanship, was at least 1,000 ft. high. Another having an altitude above the sea surface of 800 or 1,000 ft. was sailed along for forty miles!

On May 10 the Invercargill sighted more than one hundred bergs between 45° S. 37° W. and 43° S. 35° W., and eight days later the Hesperus, in 44° S. 39° W., passed a berg with an altitude of 400 ft. as measured by sextant. Another was brown and black, looking exactly like an island under way. The Loch Torridon, Captain Pattman, was hemmed in by ice on every hand in 45° S. 34° W. On the 21st Captain Rugg, of the Neotsfield, reported that on the 17th fog shut down in 49° S. 46° W., and lasted till the 20th. On that day she was in the midst of many icebergs about 400 ft. high in 46° S. 38° W., and only a small channel a mile wide visible. Her course was shaped for the opening, and for seventy miles not a break could be seen in the ice to northwest, and very few openings to the southeast. The last iceberg was seen in 42° S. 32° W. on the 22d.

The County of Edinburgh, June 2, in 45° S. 37° W., passed numerous icebergs ranging from 200 to 900 ft. in height strewed over a path one hundred miles long. Eight days later the Eden Holme sighted many bergs 200 ft. high massed in the shape of a crescent. One of them had evidently turned over not long previously, and was of a dark green color with brown or dark red patches. The J. W. Burmester sighted a huge berg very dangerous to navigation in 44° S. 38° W. on the 11th.

Five days later the Clan Grant saw several very large bergs in the same position, and others which were only awash. On the 18th the Lady Palmerston, when somewhat to the southeast of the Falkland Islands, was in company with two large bergs about two miles in length. From the 20th to the 24th she sailed through an immense number of bergs extending 180 miles from south to north and 160 miles from east to west. On the 22d she was fairly walled up by floating icy mountains. The Stanmore, on the 17th, during thick weather passed three large bergs in 45° S. 39° W. Next day, when a clear came, she was found to be encircled by bergs, while, at the same time, a heavy northwest gale prevailed. Such are the amenities of a southern passage. Some of the icy masses were weathered by only a few yards, owing to the intense darkness. Captain Nickels feared lest at any moment

she might be completely blocked, but luckily, she escaped without damage except the smashing of her forward boats. Sixty large bergs were left behind during twenty-four hours, some of which were five miles long, and almost flush with the water. The presence of the latter was only determined by the sea breaking over them.

On the 18th the bark Alice, Captain Swain, when in 44° S. 33° W., passed a solitary straggler 400 ft. high, and next day sailed along a solid body of ice for thirty-five miles, made up of not less than 300 bergs. On the 20th she sailed forty miles along one side of a solid mass of ice varying in altitude from 20 to 400 ft.

The German ship Roland on the 18th passed over 100 icebergs close together in 42° S. 34° W., and some of these were two or three miles long. The bark Parsee sighted a berg on the 20th in 45° S. 38° W., which was at first mistaken for an unknown island. It was much blackened and apparently very thickly coated with earthy matter and stones. On the 21st, in 41° S. 35° W. she sailed 40 miles along one side of a compact mass of bergs considerable in individual size and extent. Five days afterward, the Gladys, Captain E. B. Hatfield, passed two islands and some very long kelp. It is not improbable that these vigias were not land as supposed and reported, but enormous masses of ice made out with difficulty. In 43° S. 33° W., on July 1, she was completely embayed by icebergs and did not get clear of ice and fog until the 4th in 40 S. 32° W. At 4 P. M. of the latter date, signs of human beings having lived for some time on one of the bergs in sight were well in evidence. On the northwest side was a beaten track, a place of refuge formed in a sheltered nook on the summit, and apparently five dead men lay on different parts of the berg.

There were no indications of life, but the wicked weather precluded any attempt at further search, and the Gladys was kept on her course. Captain Hatfield was of opinion that the two islands first seen were the Aurora group searched for unsuccessfully by Weddell and others many years ago. Icebergs, however, afford a sufficient explanation in every case, and this view is confirmed by later reports. The Lady Cairns on the 21st, in 52 S. 46° W., sighted two very large bergs, while the sea all around was covered with smaller pieces and drift ice. Her last ice was seen on the 25th in 40° S. 34° W. The Kinfauns, in 42° S. 33° W., on the 28th passed two bergs 400 ft. high and 3 miles long. At daylight of the 29th the sea surface presented an imposing appearance. Ice was on every hand, and some of the bergs were 500 feet high and 12 miles long. On the 31st, a continuous chain of tremendous bergs trending from north to southwest, without an opening, was sighted in 39° S. 29° W. She was surrounded by bergs on August 1, varying from 200 to 600 ft. in height and from two to three miles in length. During the forenoon, while carrying a press of canvas to get out of the swarm before nightfall, she passed at least a hundred. Some were level with the sea surface and very dangerous on a dark night or in thick weather. She sailed four hundred miles in the presence of ice, and the last berg was seen in 38° S. 27° W. on the 2d. The weather was remarkably warm, having regard to the close proximity of ice, with the air temperature ranging from 44° to 54° and the water about 3° lower. Some of the bergs were very black and tabular in form, others were of the most fantastic shapes imaginable. Lots of small pieces lay to leeward of the bergs, but to windward was clear water. On the 7th, the Euphrates, from Rio to Calcutta, fell in with her first berg in 38° S. 31° W. Next day, in 39 S. 27° W., there were seen 50, varying in height from 3 to 300 ft. The low bergs were deemed most dangerous. She passed the last one on the 11th in 40° S. 18° W. The Oriana, Captain Davies, in 37° S. 27° W. on the 8th sighted much ice. Eight bergs were above the horizon at the same time, the largest being about 130 ft. high and 2 miles in circumference. The Pass of Balmaha, Captain Tovar, on the 23d in 50° S. 39° W. sighted a berg right ahead in foggy weather, and stray masses were passed each day to the 28th in 44° S. 34° W. when icebergs were all around her. At 7 A. M. of that day 96 bergs were counted from the deck, some being 250 ft. high and 2 miles long. An impenetrable icy barrier appeared ahead, so she was kept before the wind for half an hour till a passage was observed under the lee of a large berg. This proved dangerous; as return was impossible, and nothing ahead but ice as far as the eye could see from aloft. There was nothing for it but to keep moving through a number of intricate passages, many of which were only wide enough to permit the ship to pass without touching. Luckily the water was very smooth, and with two men at the wheel, she quickly answered her helm. The bergs seemed in every stage of decay. Some were tabular, wall-faced cliffs, with upper surfaces like planes of frosted silver; others were obelisks, towers, and arches. It was impossible to determine how far the ice extended east and west, as the ends of the barrier could not be seen from aloft. In the early morning the temperatures of air and sea were 42°, but at 10 A. M., in the thick of the ice, the water was 38° and the air 52°. The last ice was seen in 39° S. In 57° S. 60° W. on the 30th, the Bay of Naples sighted a berg 150 ft. high and 1 mile long, and another 300 ft. high and five miles long in 53° S. 46° W., on the 5th September. The Kilbrannan, from Newcastle, N. S. W., to Mollendo, passed bergs between 49° S. 176° E. and 47° S. 179° W., on 13th; some 400 ft. high and a mile on the water line. Temperature of the water throughout the night 44°, air 42°. On the 14th a number of bergs hove in sight, and an ice island varying in height from 50 to 400 ft., with a side of 5 miles. She saw about 30 bergs in all, and during the time she was among them the temperature of the sea was 42° to 46° and the air 2° less. On the 26th, in 46° S. 179° W., the City of Glasgow fell in with 13 large bergs. The Galgate met numerous ice bergs and ice islands in the South Atlantic. On 28th, in 49° S. 42° W., there was one 250 ft. high and 2 miles long, and next day another of similar dimensions. She sailed between two huge icebergs on October 1, in 48° S. 35° W., and next day steered through an archipelago of bergs, 200 to 300 ft. in height and from 350 to 3,000 ft. in length. On the 5th and 6th, in 42° S. 27° W., she passed quite 400. Many of these were of a dark color, but the majority were pure white. From the deck 26 large bergs were counted at one time. When passing through this ice-bestrewn water, its temperature seemed very little affected, even when within a cable's length of a berg. The air temperature kept generally about 2° above that of the sea, which was for many days of a green color. On the 1st, in 49° S. 44° W., the Æolus sighted a berg 300 ft. high and 2 miles long, and innumerable like dangers from the 4th, in 44° S. 31° W., to the 8th, in 40° S. 26° W. The Roderick Dhu, Captain P. Howe, in 49° S. 43° W., passed a tabular berg fully 300 ft. high and half a mile long. Two days later there were 40 in sight at daybreak of all sorts and conditions. Some were of a dirty green color, and others brown, so that if white ice had not been about Captain Howe might easily have mistaken them for land. There was no perceptible change in the temperature of air and sea, both standing at 49°. At 5 P. M. the sea was 2° colder, and shortly after a huge berg appeared on the weather bow. At midnight she seemed to have run into a bay, so stood out again. The majority of the bergs around were black. Those level with the water were most dangerous. Having cleared this barrier sail was made, and very soon another similar barrier was raised which looked like a solid wall of bergs 300 ft. high. She got safely through a passage about 500 ft. wide. As the biggest berg drew near, a large piece like the whole face of it broke off with a loud noise and sent the spray to a great height. These bergs all seemed in a state of speedy dissolution, and one had a submerged promontory about 400 ft. long plainly visible from aloft. Another barrier came into view almost immediately, but its bergs proved to be smaller and more scattered. She cleared all of them, but some were quite close enough to jump upon. The last was passed in 43° S. 33° W. On the 17th the Curzon, in 44° S. 31° W. was in sight of 50 bergs, some of which were 500 to 1,000 ft. high. The Urania, in 43° S. 35° W., sailed 150 miles along a solid icy mass stretching from E.S.E. to W. N.W. without a visible opening. On the 14th the steamship Coptic, homeward bound from New Zealand, met some enormous icebergs 250 ft. high along the 46th parallel between the 180th meridian and 174° W. The steamship Aorangi, Captain Sutcliffe, within 24 hours of leaving Lyttleton, N. Z., in 46° S. 178° E. sighted many bergs up to 50° S. 171° W. Several more, and a quantity of small ice, were also observed in 54° S. 135° W. Another steamer, the Star of England, left Lyttleton on the 18th and next morning a huge berg hove in sight. A little later her engines had to be stopped, as she was completely surrounded by bergs. Nothing but ice, 300 ft. high, could be seen from aloft. She cleared this during the afternoon, and kept away to the north of Chatham Islands. At 11 P. M. of the 20th, in fog and rain, she passed another large berg in 43° S. 170° W. Her passage is said to have been lengthened by at least two days in consequence of this unexpected difficulty.

In the South Pacific Directory there is not any mention of ice so near the coast nor within 500 miles of that position. The four masted ship Liverpool sighted a berg on the 23d in 55° S. 94° W. which was 800 ft. high and half a mile long. On November 3, the John Ena saw a large berg in 46° S. 16° W., and the Superb passed ice on the 40th parallel between 28° and 21° W. She was in considerable danger therefrom on several occasions. The bergs were much discolored by brown layers and irregular patches. In the daylight, with no white ice in the vicinity, some of these drifting dangers would have been taken for rocks, and Mr. Gray, from whose report we quote, believed that some of the vigias in this part had their origin in ice of this description. The Florence, on December 28, in 48° S. 45° W., sighted four bergs 8 to 10 miles long, 4 miles broad, and 200 ft. high. Next day, in almost the same position, the Drumcraig, running before a westerly gale in thick weather, observed a large ice island. She hauled her wind and stood south, being unable to weather the northern end of this mass, which was fully 300 ft. high and 20 to 30 miles long. The masts of some ill-fated vessel were faintly discernible alongside of it, but the weather prevented closer scrutiny. Other bergs were sighted until the 31st in 47° S. 46° W.

The Arthurstone, on January 10, 1893, ran into an iceberg in 49° S. 44° W. She lost bowsprit and foretopgallant mast, and received serious damage to her bow plates. Captain Adams reports that pieces of ice, weighing several hundred tons, fell from the berg's summit into the sea. Had one of them come inboard, she would certainly have foundered with all hands. From 10th–12th, in 50°–48° S. 40°–42° W., the Candida sighted much ice, and had 35 immense bergs above the horizon at one time. The John Cook, Captain Lillie, had a narrow escape during a heavy gale while surrounded by icebergs in the South Atlantic. On the 13th many large ones were seen, and next morning there were at least 30 all around, one of which was 600 ft. high and a mile long. At noon her position became critical, as the ice hemmed her in on every side, and it seemed almost impossible that she could avoid collision. There were 50 in sight, ranging from 100 to 600 ft. in height. Toward dusk one broke into pieces. The Norwegian ship Breidablik on 15th, in 49° S. 44° W., saw two table-topped bergs 200 ft. high and 2 miles long, and next day four more. On the 17th the Errol passed 50 bergs between 47° S. and 51° S., and three more on the following day in 48° S. 44° W. The American ship Kenilworth was two days in the ice in 48° S. 77° W. In all, about 25 bergs were sighted, some being 500 ft. high and one 3 miles long. On January 10, in the early morning, the Wasdale passed small pieces of ice, and while wearing ship a berg was only just cleared. Suddenly the sun came out, and then she was found to be completely surrounded by bergs. One was 300 ft. high and 3 miles long. Dense fog shut down again, and on the 11th at sunrise after dodging about all night she was in a horseshoe-shaped bay 20 miles deep, 10 miles across the middle, and 4 miles at the entrance. The Stracathro was in company. While passing one berg a great quantity of sand was noticed in one corner running in fine seams, giving it the appearance of marble. When 300 yards distant the nearest end collapsed, and the berg turned right over. Her last ice was in 47 S. 42° W. The Loch Torridon, Captain Pattman, on the 17th, in 53 S. 46 W., sighted two large bergs. Two days later, when 2° further north, she threaded her way between numerous bergs ranging in size from quarter mile to 3 miles in length and 500 to 1,000 ft. in height. In the afternoon of the 19th, an immense ice island ahead gave no signs of open water. She sailed 50 miles along one side of it from south to north, and its extent to westward could not be determined, although nothing but ice was visible in that direction from aloft. The bays and indentations along its coast were full of bergs and detached ice. Until 8 A. M. of the 20th, innumerable bergs were passed. At this time one abeam to the eastward probably exceeded all other previous measurements. It was at least 3 miles long and 1,500 ft. high! The Clan McLeod, on the 28th, passed icebergs 15 to 20 miles long, and a dozen others, several of which were 200 ft. high. In February, the Grandee, in 42° S. 43° W., sailed between icebergs for 250 miles. The Berean passed 12 bergs of huge dimensions between 51° S. 45° W. and 46° S. 40° W. The Anglesay, on March 3, in 52° S. 46° W., sailed among icebergs for 300 miles, and from the 4th to the 7th the Penrhyn Castle sighted many bergs, in 50° W., between 51° S. and 47° S. Space forbids further mention at present, but fresh reports are coming in every day of bergs met with in February and March.

Casualties consequent on this exceptional gathering of bergs have not been so numerous as might fairly be expected. In addition to the Duntrune, and the Arthurstone, before mentioned, the iron ship Templemore, homeward bound from Australia, was crushed by ice off Cape Horn and foundered. Her crew, after exposure in open boats, managed to fall in with the Dunboyne and safety. The French bark Galathee and the Cashmere have both put into Rio with all headgear gone and bows stove in after collision with bergs. The Loch Rannoch, on 16th February, in 51° S. 49° E., sighted a large berg right ahead, put the helm hard up to clear it, but without avail. She grazed the berg with her yardarms and made matchwood of some. This danger was 400-500 ft. high and a mile long. Sea surface temperature, although carefully taken, gave no warning. In the morning ice was all around, and one berg had a large brown rock embedded in it.

On page 59 of the February "Notices to Mariners," issued by the Board of Trade, a note of warning was struck, as "it appears probable that there has been an unusual dislocation and spreading north of the southern ice, and caution should be used." 1892-1893 has undoubtedly made the record for southern icebergs in every way. They have drifted farther north, been more numerous, and loftier, than for many a year. A berg 1,000 feet high seemed to some shorefolk almost incredible, but now Captain Pattman gives 1,500 feet as his highest, and, like Oliver Twist, we ask for more. It would be worth every effort to measure the altitude of such lofty bergs, and thus leave no room for the scoffer. Another peculiarity of this strange batch is the earthy matter upon them. The strange story of five dead men on an iceberg related by Captain Hatfield, of the Gladys, and the ship's spars, supposed to have been seen alongside another, by the captain of the Drumcraig, afford food for reflection.—*Nautical Magazine.*

SANITARY MOTES AND BEAMS.*

OPENING ADDRESS BY THE PRESIDENT.

ALBERT L. GIHON, A.M., M.D., Medical Director, United States Navy.

"And why beholdest thou the mote that is in thy brother's eye, but considerest not the beam that is in thine own eye?"—Luke 6: 41, 42.

THESE words of the Teacher of Humanity, which "the beloved physician" of the first century has recorded, are an appropriate text for the opening address in the important section with whose conduct I have been charged in this Congress.

Time was—and that no long time—when Hygeia, the neglected Cinderella of the medical family, slunk unnoticed among menials; now that she graces the *salon*, her proud sisters caress her and suitors court her favor. As an old admirer of this fair mistress, whose colors I have worn through youth and manhood, I may be pardoned the personal exultation that I have lived to see her suzerain.

The ascendency of hygiene has greatened and glorified medicine, without dimming the luster of any other branch; but though her cult is established, her mission has not ended with the recognition of her supremacy and the faithful following of her own ilk. To-day she turns to the people and their rulers outside the medical fold, and demands the place in their councils that is hers of right. A makeshift share in the administration of the sanitary interests of the country has been grudgingly allowed, but the inexorable demands of modern enlightenment cannot be satisfied until the conservator of the public health shall sit a peer among the rulers. The minister of war may build mighty engines for destruction and defense and muster vast armies and navies, which disease can disperse with a weapon so tiny that the eye cannot discover and no mere military expedient antagonize. The minister of finance may fill his treasure houses with gold and silver by the ton, which can buy human souls, honor, virtue, independence, everything but the boon of health, God's free gift to man, through which alone he can be like his own glorious image. Commerce, agriculture, manufacture, fishery, mining, and all the industrial occupations of the human race, which are now the objects of the intelligent supervision of cabinet ministers, who are grand masters of political economy and social science, cannot thrive without vigor of human blood and brains and brawn, which are the machinery of these occupations; yet until this decade it has not been thought that the intelligent supervision of a grand master of the divine science of medicine was necessary to preserve this vigorous health of the community, without which even these other ministers can themselves only imperfectly perform their own offices of administration.

When I entered the service of the government of the United States as an officer in the medical department of the navy, nearly forty years ago, with a minimum of experience and a maximum of enthusiasm and an exalted opinion of the dignity and responsibility of my charge, which a lifetime has only intensified, I was astounded at the total ignorement of sanitary provision then prevailing in the naval service. Medical officers were curtly reminded that their opinions and

* Read before the Section in Hygiene, Climatology, and Demography of the Pan-American Medical Congress, September 5, 1893. Abstract from *The Sanitarian.*

advice would be asked when desired; their protests at acts that filled the hospitals and mortuary lists were contemptuously unheeded; they were reproved for officiousness and punished as insubordinate; disabled sailors and marines were discharged and their places and those of the dead were filled without regret or remorse, but with the shameless boast that "if men die we can ship others," like the Netherland commodore, some of whose crew had been killed by the careless firing of a shotted saluting gun, who accepted the apology for the accident with the nonchalant remark, "Dere are plenty more Dutchmens in Holland."

The battleships and cruisers of modern navies are not more unlike the brigs and sloops of war forty years ago than are the cleanly, well-fed, comfortably clad and cared for enlisted men, who go on shore daily, subscribe for newspapers, and write letters—a different race from the begrimed and degraded "shell-backs," who were ordered to their work with curses and punished with brutality for offenses which neglect and ill-treatment had incited. The naval and military establishments have considered the beam in their own eyes, but civil authorities are still purblind to the necessity for organized intelligent sanitary supervision and direction, and grope for succor only under the flashlight of a pestilential visitation. The following from a recent editorial in an influential journal is pertinent: "Whether cholera has or has not made its appearance at Chester, which is practically one of the suburbs of Philadelphia, it is certain that the conditions reported to exist there are in the highest degree favorable for the introduction and spread of that disease. All accounts represent the neighborhood in which the alleged cases occurred as filthy beyond description, and occupied by a class of persons who pay no attention whatever to the laws of health or personal cleanliness. Of course, the country now has the pleasant assurance that the place is to be thoroughly cleaned and effectively quarantined; but why were not the steps necessary for the protection of the public health taken before the resulting disease, whether cholera or not, had gained such a footing that already five persons have died from it? The time to lock the stable door is before the horses housed therein are stolen, and the way to treat contagious diseases is to prevent their appearance, and not wait for them to gain a foothold and then try to stamp them out."

The secretary-general has announced that the proceedings of this section and its congener, the section in marine hygiene and quarantine, will constitute a special feature of this congress. It is therefore incumbent upon us before adjourning to declare very positively the opinion of the members of this section, experienced practical sanitarians from every country of the western hemisphere, that the interests of the public health must be intrusted to a department of the government especially charged with their administration, with equal independent executive authority as given to other national departments. Temporizing legislation under the spur of emergencies does not befit this age. As the enlightened physician seeks to prevent his charges becoming ill, so should the guardian of the public health be able to forestall these emergencies, whose pecuniary cost, in money expended and wasted, in trade paralyzed and diverted, in labor and its wages lost by the sick and terrified and dead, in a single epidemic, exceeds that of maintaining an efficient sanitary service for the whole country for a whole year.

The fault of the medical profession has always been its lack of bold assertion of its rights; but it can no longer hesitate to declare to trade and commerce and agriculture and manufacture that the health and vigor which are essential to prosperity cannot be secured by their own unskilled, uninformed efforts. They must learn, as the military services have learned, that powerful armies and navies are the results of able and untrammeled medical departments. It is as unwise to confide the care of the national health to a financier, however astute, as to expect a postmaster-general to understandingly control a bureau of agriculture, or a fishery commissioner to best administer the affairs of the public schools, and an attorney-general to direct the mining industries. The health of a nation is a national consideration involving international co-operation. There should be no priority nor clash of sectional interests. State lines are not respected by epidemic intruders. No State barrier can be so defensive and impenetrable that the toxiferous germ cannot pass through. The precise form of administration may be left to legislation, the indispensable requisites being that it shall be national, that it shall have parity of voice and influence in the national councils, that it shall have independent executive authority under the limitations common to other departments, and that it shall be intrusted to educated and experienced medical men, who alone are competent to assume its responsibilities.*

I have not wandered from my text in thus pleading for a national public health establishment. Spasmodic tentative provisions in emergencies are nothing but attempts to discover *motes* from abroad when the *beams* at home should first receive consideration. To parallel further and in another sense, the scientific tendency of the day is literally toward mote hunting through microscopes instead of using our human eyes upon visible abominations. The sanitarian, official or amateur, need only look about him to be appalled at the spectacle of indifference of rich and poor, high and low, to dangers far greater than any from cholera microbes, which confront them every hour, and it may be worth our while to indicate some of these beams in our own eyes, which we complacently refuse to see, while we magnify the motes on our horizon.

The preventable disease which kills more of the human race than cholera and yellow fever together, and in its ordinarily slow process of killing lessens the productive power of a community directly by the enfeeblement of its victims and indirectly by its demands upon members of households and eleemosynary institutions for the care of these chronic invalids—tuberculosis—is tolerated with as little concern as the Mongolian exhibits for smallpox or the creole for yellow fever and malaria. The consumptive, whose traits no professional acumen is required to recognize, frequents our crowded thoroughfares, sits beside us in unventilated street cars and at the hotel table, occupies Pullman sleeping berths, and shares the steamship stateroom, wholly unrestrained and innocently ignorant that he or she may be sowing the seeds of disease among delicate women and children.

Any one may verify this who uses his eyes for the purpose along the railway and coastwise steamer routes to our invalid resorts. Within a twelvemonth, on my way to Mexico by rail, I was fellow-passenger with two invalids in the advanced stage of phthisis, *en route* for San Antonio, one of whom occupied the opposite berth and the other one diagonally across the car, so that I could see and hear them coughing and expectorating, with only such attention as well intending but unskilled relatives could render. They had no vessels for receiving their sputa, which were discharged in their pocket handkerchiefs, to be scattered over pillows, coverlets and blankets. They left the car in the morning, and I saw those same berths—it is true, with change of linen sheets and pillow cases, but with no change of blankets, mattresses or pillows—occupied that very night by other travelers, who were thus subjected to contact with a pathogenic microbe far more tenacious of life and power of evil-doing than the dreaded cholera spirillum.

One has only to sit in a crowded street car on a winter day and watch the clouds of respiratory steam circling from the mouths and nostrils of the unclean and diseased into the mouths and nostrils of the clean and healthy, as the expiratory effort of the one corresponds with the inspiratory act of the other. The road is short but straight and sure from vomica and mucous patch to the receptive nidus in another's body. Who that has ever had forced upon him an aerial feast of cabbage, onions, garlic, alcohol, tobacco and the gastric effluvia of an old debauchee can doubt that aqueous vapor can transport microscopic germs by the same route?

Not long ago I traveled by sea from New York to Charleston, and for two nights was cabined with some twenty consumptives going to Florida. The air was chilly, and they huddled around the stoves and fearfully and fearlessly closed doors and windows, until the atmosphere became stifling and surcharged with their emanations and the dried sputa, which they ejected on every side. It was comparatively easy to escape during the day by staying on deck, and I slept with my stateroom windows wide open, but the curtains, carpets, pillows and mattresses had been saturated by I know not how many expectorating predecessors.

I have visited fifty smallpox cases a day, have gone through yellow fever wards and stood by cholera bedsides with far less apprehension than I experienced on that trip; yet it was one taken by many thousands of people, who would have been terrified to know that there had been a case of cholera within a mile to leeward of their homes. Recall in your several experiences the instances of members of a family who have occupied the same chamber and bed with a gentle and beloved invalid aunt or sister and those of tuberculous husbands or wives, who have become ill like them with pulmonary phthisis attributed to everything but the manifest cause.

In former years I preached a crusade against another virulent communicable disease, in the interest especially of innocent and helpless women and children, and for a time I was gratified to find that husbands and fathers began to realize, from the numerous indisputable instances of innocent infection I was able to report, that syphilis might be, as it had been, contracted from combs and brushes and rough-edged drinking vessels in hotels, sleeping cars and boarding houses, from pens, pencils and paint brushes that had been held between diseased lips, from dirty old bank notes, from street venders' toys, from a lover's kiss, a stranger's caress, or a nurse's ministrations.

Supported by an array of cases of infected children, young girls and elderly men and women, the committee of the American Public Health Association of which I was chairman advocated the enactment of a law placing venereal disease in the category of other communicable affections, and punishing its transmission as a misdemeanor; but there were too many of the self-righteous blind to these beams in their eyes, who thought it wiser to seek to exterminate by ignoring its existence and never uttering the name of a disease that has done more harm to mankind than all the diphtheria, typhoid, smallpox, measles and scarlet fever which are so carefully isolated and their statistics so regularly collected and promulgated—a disease that travels with the missionary to Asia, Africa and the Pacific, and decimates bodies faster than he can whiten souls.

I do not expect that all who have eyes will see as I do, or, having ears, hearken to what I say. The idle and perverse generation of the first century will have its following in the twentieth, and men and women will continue to do the insanitary things they ought not to do and leave undone the sanitary precautions they ought to take, despite our warning, our imploring, our advice, or our denunciation.

However benevolent and beneficent the hygienist's aim, his unappreciated, unrequited and often unprofitable labor is enough to deter him from what has been derisively described as only an effort to procure the survival of the unfit, and thus thwart nature's own attempt to rid the world of them. He encounters another obstacle to success as aggravating as the disbelief in the necessity for his work. The authorities listen to his warnings, and then employ their own perfunctory and superficial methods of protection. Told that absolute cleanliness is the fundamental fact of sanitation, street cleaners are set at work brushing the surface dirt into little heaps, which passing vehicles again distribute, or the winds carry into the open windows of adjacent residences. The refuse of the household is deposited in vessels on the sidewalks of crowded thoroughfares to be emptied after a time into collecting carts, from which clouds of dust envelop passers and circulate back into the houses—*living* dust, for Manfredi found an average of 761,521,000 microbes to the gramme of the street dust of Naples, from which he cultivated pus, malignant œdema, tetanus, tubercle and septicæmia. Swarms of flies feed on the decomposing contents of exposed garbage pans and buckets, and carry their tiny germ-laden booty into the butcher shop of the poor and the kitchen of the millionaire.

Who can dispute that if the hair of a Newfoundland dog could transport yellow fever to a distant Mississippi town, and a newspaper printed in an Ohio village where smallpox was raging could fatally infect a United States consul in a foreign port, where the disease did not exist; that a cloud of dust, a swarm of flies, or a single fly—as Sawtschenko, Simmonds and Sternberg demonstrate—can disseminate cholera and become a focus of infection, which would have been impossible had ordinary care been exercised in preventing the exposure and promptly destroying the discharges and excreta of those already sick? Cities are reported clean whose sanitary inspectors have merely walked through crowded tenements, a hundred or more a day, and been satisfied with external evidences of brush and broom, leaving carpets and rugs unlifted; pieces of heavy furniture, with the fluff of years behind and beneath unmoved; and closets, cupboards, pantries, storerooms, attics and cellars undisturbed. The cellars of our great cities—and I speak with personal knowledge of many in New York, Brooklyn and Philadelphia—are greater abominations than even filthy living apartments.

The New York *Herald* of August 8, narrating the death of two children by falling from a window on the fourth floor of a tenement at 204 West Sixty-first Street, said: "To get at the bodies of her children, the frantic mother had to go through the cellar of the house. There she waded through indescribable filth, almost knee-deep, to where her children lay, when the foul odors overcame her, and she fainted." It added: "The sanitary superintendent issued an order that the cellar must be cleaned out within twenty-four hours." Do you believe that it was the only one of its kind that needed cleaning? No city can be accounted clean until its ordinances require every cellar door to be widely opened to sun and air—that royal pair of germicides; every cellar to be emptied of its refuse; every cellar wall and ceiling to be scraped and whitewashed; every cellar floor to be taken up if rotted, and sprinkled with lime if uncovered—a tedious and expensive process; but effective sanitation, costly as it must need be, is cheap beside the outlay of a single epidemic.

There are underground foulnesses in all our great cities of which they should be rid at any cost, as where rag pickers and bone gatherers collect their filthy stores, and Italian street corner fruit sellers keep their decomposing bananas, grapes and oranges, till, rubbed off by dirty pocket handkerchiefs, they are exposed for sale, glistening after their repulsive polish with impure saliva. If some mote hunter, loth to see so huge a beam, chooses to find solace in disbelief, I might be able to shock him by declaring that I have seen the figs he munches unconcernedly flattened in their pretty boxes, in a country where syphilis reigns, by questionable thumbs moistened by equally suspicious saliva.

Shall I, while revealing insanitary horrors, dare lift the sweeping train of the fair promenader, fashioned after that of women in other countries who never walk upon the streets, and show the nasty mess of spittle, excreta, mud and dust she gathers from the sidewalks upon her white skirts and silk stockings? She will not believe me; but the bacteriologist, who scoops the mud from between the cobblestones of the streets to find it swarming with microscopic life, can gather as rich a harvest of microbes from these same dainty undergarments.

Nor are these the only beams we overlook in our search for motes. Dr. Graham, bacteriologist of Starling Medical College, in response to an official inquiry by a member of Congress, reported that he was able to obtain thirteen colonies of two kinds of bacteria from one dirty, worn bank note; and the *Medical Record* of January 21 of this year states that a British bacteriologist discovered nineteen thousand microbes, including those of tuberculosis, diphtheria, and scarlatina, vegetating upon a single note.

Other harborers of morbific germs are the textile fabrics employed in the furnishings of street cars and stages, which the chairman of the sanitary committee of the New York Board of Health reports as "a menace to public health by reason of their continual exposure to uncleanness and infection from the clothing of diseased and filthy passengers," which, like their grimy bodies, may be foul with the sputa of diphtheria, tuberculosis, or syphilis, the desquamations of scarlatina, measles, or erysipelas, the emanations of typhus, or the alvine discharges of cholera or dysentery. A commendable league of zealous ladies, who are seeking to prevent the abominable practice of expectorating in public vehicles, induced a few car companies to display placards to the effect that "Gentlemen are requested not to spit on the floor;" but these appeals, intended for beasts who were never gentlemen, were hung in inconspicuous places or covered by other notices, and the spitters continue to discharge their syphilitic and tubercular sputa on the floor mats, to be taken up on ladies' petticoats and carried to their homes. The spitter and the other beast, who voids his impure nasal secretions where it suits him, are largely responsible for the spread of influenza, for, according to Pfeiffer, the discoverer of its bacillus, "its contagium is found in the moist secretions of acute cases in the discharges from the nasal and bronchial mucous membranes."

Further detail would be out of place in an introductory address to this section. Let it suffice to point to the fragile spirillum of cholera, which we are exorcising by "bell, book, and candle," as illustrating the dreaded *motes* of my text, and to the sturdy, robust bacillus of tubercle as the *beam* we will not consider. "Cholera," says Ernest Hart, "can only be drunk and eaten. It cannot be caught and breathed;" but the tubercular mischief maker, who finds the ever-open door of the respiratory passages his readiest approach, may also enter at any or all the orifices of the body. Among 1,000 autopsies Osler found 275 with tuberculosis; among 8,873 patients in the surgical clinic at Wurzburg, one-seventh (1,227) were tuberculous; the necroscopic statistics of Harris and others "show that one-third, perhaps over one-half, of the people who live to middle age have some form of tubercular infection;" and Dr. Williams, of Johns Hopkins Hospital, estimates that tuberculosis of the female generative organs is four times more frequent than generally supposed

* These propositions were unanimously adopted in the form of a resolution in these terms by the conjoined Sections in Hygiene, Climatology, and Demography, and in Marine Hygiene and Quarantine, and reported to the general session of the Congress, by which it was referred to the International Executive Committee, which returned it with its indorsement and direction that it be transmitted as the voice of the congress to the executives of all the countries represented therein.

(*Medical Record*, March 18). Can any more obvious method of direct infection in these cases be imagined than the trailing skirts of women, gathering tubercular sputa from the pavements?

The sanitary inspector is destined to become the most important agent of future civic administration. The perfunctory burning of a pan of sulphur in a diphtheritic chamber, the sprinkling here and there of a solution of corrosive sublimate, or the substitution of the sweeter scent of thymol, pinol, or some newer "ol" for the foul odor of the privy, will not then be the tolerated limit of his interference. All that science teaches and all that intelligence can devise will be exacted of him. A sanitary inspection will be a deliberate, painstaking, critical examination of nooks and corners and their disinfection, the flooding of the lairs of microscopic motes, and the deluging of unsightly beams with those unstoppled, unpatented, inexhaustible germicides—air and sunshine.

Coincident with the approaching Eleventh International Medical Congress at Rome, and its fitting complement, there is to be an exposition of medicine and hygiene; and significant of the share accorded sanitary science in a medical congress representing the highest modern professional attainment, it will be noticed that of the *ten* classes which, in their *ensemble*, make up the exposition, *five* are exclusively hygienic—to wit: (4) plans, models, and *materiel* bearing on school management and sanitary civic organization (*riordinamento urbano*); (6) plans, models, and *materiel* for hygienic constructions; (7) apparatus and furniture for hygienic uses in the interior of common dwelling houses and public offices on every scale; (8) *materiel*, appliances, and accommodations for the practice of personal hygiene; and (9) plans, models, and appliances for the hygiene of the working classes. Three are partly hygienic—to wit: (1) apparatus, *materiel*, and plans of buildings for scientific and technical investigation in therapeutics, biology, and hygiene; (3) articles and appurtenances requisite in salvage service and in *assistance publique;* and (10) books atlases, photographs, and such like recently published and having reference to the medical, biologic, and hygienic sciences.

Two only of the ten are exclusively medical and surgical—to wit: (2) apparatus, instruments, and *materiel therapeutique* in the various departments of medicine, and (5) plans, apparatus, and furniture for the purposes of the divisional surgeon in cities. Additional to these, special classes are devoted to hydrology and balneotherapy, and to the Italian Red Cross Society, both of which are practical outcomes of sanitary endeavor.

I do not forget that climatology and demography, as well as hygiene, are within the purview of this section; but what are climatology and climatotherapy but applied hygiene, and what demography but the demonstration of the results among masses of people of sanitary or insanitary conditions? The climatologist is of necessity a hygeologist. The Materia Medica and Pharmacopœia are not his text books. Physical geography, meteorology, hydrology, balneology are his scriptures and gospels; the vivifying light, invigorating air, and healing springs and waters his armamenta—his anodynes and hypnotics, his roborants and eutrophics, his alterants and excernents. The high professional standing of the American Climatological Association, one of the constituent bodies of the Congress of American Physicians and Surgeons, and the distinguished climatologists who are with us to-day and who are conspicuous in every international congress of hygiene, are evidences of the place in medicine of climatotherapy, the practical end of medical climatology—that broad specialty which robs so many graves of untimely victims and makes so many, heretofore without hope, able, if not to take up their beds, at least to get out of them and walk. The field of the climatologist is as broad as the habitable surface of the globe—in the high altitudes of Colorado and the Alps: in the odorous pine forests of Norway and the Carolinas; on the seashore or upon the wide waste of waters and their islet oases swept by ocean breezes.

Our American vital statistics are not yet piled high enough to form the foundation for a substantial superstructure of demography. The great caldron in which we are mixing Celts and Saxons, Semites and Aryans, with a seasoning of syphilis, tuberculosis and insanity, is simmering with what ultimate homogeneity can only be conjectured.

When immigration was a tiny stream, however muddy and noisome, poured into a rapid river of pure water, it was soon lost in the crystal fluid; but now that huge sewers are discharging their fœtid pestilential torrents into a placid lake that has no outlet, the lake itself becomes turbid and unclean. Already in the *culs-de-sac* which are nearest the open mouths of these foul sewers and receive their floating scum—the prisons, reformatories, almshouses, insane asylums, and hospitals—this filthy, debased, and diseased foreign element is ascendant, and our demographers have a simple task in representing its volume by numerical statistics. Dr. Frederick H. Wines, the distinguished compiler of this portion of the census of the United States for 1890, demonstrates by the indisputable evidence of figures that while the foreign born constitute only 17 per centum of our total white population—in round numbers about one-sixth—yet they furnish over half of all the paupers in the almshouses of the country. It is evident that the traits of the Saxon are disappearing from our national complexion, and if the proper solution of the negro question be, as suggested by certain prominent Afro-Americans, to bleach it out by admixture, we may expect the hue of our descendants to be decidedly tawny.

The most zealous demographers of this decade are the French, who have been spurred in their statistical researches to discover the causes of the too evident depopulation of France of its native races; but are we not again refusing to consider the beam in our own eyes in not giving heed to the operation of similar conditions in our own country? Dr. Billings announces that our birth-rate has fallen from thirty-six in one thousand inhabitants in 1880 to thirty-one in one thousand in 1890. The twenty to thirty children of our ancestors, the dozen or more of our great-grandmothers, have dwindled progressively to five or six, then to three or four, until to-day one or two or none represents the fecundity of the educated classes. *The Independent*, referring to New England Puritan life, says: "Large families abounded. According to Cotton Mather, one woman had twenty-two children and another twenty-three by one husband, and a third was mother to seven-and-twenty. Sir William Phipps was one of twenty-six children of the same mother. Printer Green had thirty. The Rev. John Sherman, of Watertown, had twenty-six children by two wives, the second spouse the mother of twenty. The Rev. Samuel Willard, first minister of Groton, had twenty children, being himself one of seventeen, as was Benjamin Franklin." The paragraphist who can now record the case of the woman of thirty-one at Cold Spring, who has become the mother of seventeen children in nine years, or that of the Georgia matron of twenty-five who rejoices in thirteen, has in newspaper parlance "a great find." The spectacle of impending maternity among our better classes is becoming more and more rare, and still more rare that of an infant nursing at its mother's breast. Only in the squalid quarters and *banlieues* of our great cities, where the English language is not spoken, among imported lazzaroni and the overflow of European ghettos, does the process of human incubation go on as God and nature intended. The laws of creation are immutable, and one has only to look beneath the disfigurement of female dress to recognize the evidences of imperfect physical development—in stooping, unsymmetrical shoulders, in meager limbs, in narrow pelves, and flattened busts. Dr. Otis exhibited at the recent meeting of the American Climatological Association, in illustration of diametric measurements of the thorax, the profiles of a number of female chests, which were supposed to be those of little girls, until he explained that they were the contours of nubile young women in Boston normal schools, like her whom Solomon bewailed in the Song of Songs: "We have a little sister, and she hath no breasts: what shall we do for our little sister in the day when she shall be spoken for?" My friend Dr. Robert T. Morris, of New York, has significantly called attention to the fact that 80 per centum of all Aryan American women have rudimentary clitorides, and he asks if evolution is trying to do away with this organ in the degenerative changes characteristic of highly civilized varieties of the *homo sapiens*, of which early falling hair, decaying teeth, weak mammary glands, and badly balanced eye muscles are other examples. Is the sexual instinct losing its potency as a maternal factor? Is marriage only a social office for the display of finery on the brides and bridesmaids and the entertainment of crowds of gaping strangers? Is the virgin wife best prepared for conception by months of preliminary surexcitation and feverish anxiety, and is a fatiguing railroad journey the best prelude to an act which should lead to the inception of a human being—the incarnation of a human soul? Has the function of reproduction come to be regarded only as a bestial and undesirable concomitant of matrimony, and lactation its vulgar, indecent supplement, and is all this attributable to physical deterioration shown by the undeveloped or imprisoned *mentula muliebris* and atrophied mammæ, and how far is this the explanation of the diminished fecundity of the Aryan American woman? These are problems as interesting to our demographers as the depopulation of France, the disappearance of South Sea Islanders, the migration of Semitic and Mongolian races, and the effects of malnutrition of indigenes of Ireland and Russia.

OIL OF AMBER.

By A. JOLLES.

AMBER oil is a product of the dry distillation of amber, and consists, in its crude state, of a mixture of water, succinic acid, and oil of amber. On standing, it separates into three layers, the lowest consisting of water, the next containing the bulk of the succinic acid, while the upper layer contains the oil of amber. By drawing off the oil thus collected, it is obtained as a dirty brown, fluorescent liquid, possessing a nauseating odor. It is insoluble in water, but soluble in alcohol, ether, benzene, and many other solvents. The oil is scarcely acted upon by dilute mineral acids, but concentrated sulphuric and nitric acids react violently with it. By the action of nitric acid much succinic acid is produced, and an orange-colored resin possessing a strong odor of musk is produced, which is used as an "artificial musk." Reducing agents have no effect upon amber oil. Treatment with animal charcoal and other decolorizing agents does not in the least improve the color of the oil. In distilling oil of amber, first water is obtained, then a yellow oil, followed by a green oil, and lastly a dark green oil. The temperature during distillation ranges between 150° and 360° C. A tarry matter remains behind amounting to about 15 per cent. of the crude oil used. The distillates obtained still possess the repugnant odor of the original oil. By carrying out the distillation, however, in a current of steam, almost odorless distillates are obtained. These distillates can be bleached by adding to them about 8 per cent. of permanganate of potash or bichromate of potash, together with the required quantity of dilute sulphuric acid. The oil is then left to separate from the water, the latter is drawn off, the oil completely dehydrated by addition of common salt or plaster of Paris, and then filtered. In the bleaching from seven to nine per cent. of the oil is lost. —*Dingl. Polyt. J.; Journ. Soc. Chem. Ind.*

VALUATION OF LEATHER GLUE.

By F. GANTTER.

ONE hundred grammes of the shredded sample are heated with 1 liter of water containing a few drops of caustic soda solution until solution is complete, when the volume of the liquid is made up to 2 liters. After the solution has been set aside for ten hours, 20 c. c. (= 1 gramme of glue) of the clear liquid are evaporated, and the residue is dried at 105 deg., weighed and ashed. The weight of the ash-free raw glue is thus ascertained.

To estimate the pure glue in the sample, 20 c. c. of the above solution are transferred to a 100 c. c. cylinder, diluted with 30 c. c. of water, and neutralized with acetic acid. Tannin solution is then added, until no further precipitation occurs; the solution is shaken, made up to the mark with water, and filtered through a dry filter. The filtrate is shaken with hide powder, and set aside for ten hours to insure complete elimination of tannin. After another filtration 50 c. c. of the solution are evaporated and the residue dried, weighed and ashed. By subtracting the weight of this residue, less that of the ash, from the weight of the ash-free raw glue, the percentage of pure glue substance is ascertained.—*Zeit. Anal. Chem.*, 1893, xxxii., 413, through *Chem. Zeit.; The Analyst.*

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